METAL INDUSTRY

17 JANUARY 1958

The Factories Report

A RAPID growth in the industrial use of radio-active materials is referred to in the annual report of the Chief Inspector of Factories for 1956 which is now available. The inspector states that the use of radio-active materials (other than for luminizing, which is the subject of existing Regulations) should, he feels, be brought under more detailed control. An expert committee, on which a number of organizations were represented, was formed to examine a draft Code of Regulations which had been in course of preparation, and as a result draft Regulations in respect of sealed sources have been published. The Regulations will cover X- and gamma-radiography, X-ray fluoroscopy and crystallography, radio-active static-eliminators and thickness gauges, X-ray thickness gauges, and X-ray and radio-active sources used for irradiation of chemicals, etc.—in fact, all known industrial uses in current practice or projected in the future.

The Report reviews recent developments in the design of machinery, the use of electrical and electronic control equipment, and safety in the Calder Hall Nuclear power station. In the field of safety, co-operation between manufacturers of equipment and machinery, occupiers of factories and the Inspectorate, is shown to be improving. The techniques of safety and the safe design of machinery are also being given more attention. Electrical and electronic control apparatus is increasingly replacing mechanical control systems. Important studies are being made to ensure the reliability of such control equipment, in the interests both of the safety of the operators and the correct and safe functioning of the equipment. In addition, the chief inspector states, great importance is attached to the incorporation of some simple form of "automatic monitor" as an additional safeguard.

Dealing with the subject of training in safety, the Report states that more firms are appreciating the need for thorough career training of apprentices, and Inspectors constantly endeavour to get training in safety recognized as a specific subject in the curriculum. Reference is also made to the Birmingham and District Industrial Safety Group, which has already, through its training courses for power press setters, had an influence on accident prevention far beyond the immediate area. Accidents by fire are also referred to in the Report which goes on to say that there is no doubt that the general public is better informed today on matters affecting health and hygiene than ever before, and in consequence the interest in industrial health has quickened, particularly among those directly affected.

The Chief Inspector says that benefits to health are beginning to accrue from legislation of more general scope than the Factories Acts. The Clean Air Act, for instance, where it has reduced the pollution of the atmosphere, has had immediate repercussions on standards of cleanliness and lighting. Separate sections of the Report are devoted to accidents at certain types of process machinery, such as power presses, baling machines, hydro-extractors, and automatic equipment. In general, however, the Report suggests that there is a downward trend in industrial accidents and an improvement in knowledge of various safety devices.

Out of the MELTING POT

Extensions

IN view of the overriding need to obtain results under close control, the "one-factor-at-a-time" approach to so many industrial processes is readily understandable. This state of affairs should not, however, be allowed to obscure the possibilities of interesting results being obtained by an approach based on permutations and combinations of a larger number of factors. Because of the difficulty and expense of actually performing all these permutations and combinations in practice, ways and means of arriving at them at least on paper, whereupon they could be given a preliminary evaluation, should be sought. In the more ambitious and complex projects, resort can nowadays be had to analogue or digital computers to simulate conditions that would obtain in practice, and to derive the final results from them. Elsewhere, much more modest means, possibly taking the form of cards representing the various factors, could be shuffled and moved about, jig-saw puzzle fashion, with a view to arriving at arrangements which imagination, tied down to existing arrangements and quite likely overwhelmed by sheer numbers, may so far have failed to conjure up. One field in which some such means of conjuring up arrangements and rearrangements of potential utility would be helpful is undoubtedly that of machining. To avoid the overloading and clogging up of the means used to effect the permutations and combinations, the factors to be manipulated could, for a start, be restricted to what, in the occasionally invaluable jargon of patent specifications, would be referred to as "metal-removing instrumentalities," with the addition of just a few modes of metal cutting as such, e.g. parting, planing, turning, drilling, etc. Among the existing arrangements, from which a start will always have to be made, the means adopted for the presentation of the existing state of affairs will hardly fail to show up the splendid isolation of gas- and arc-cutting processes. The subsequent rearrangements should not take long to lead to combinations of these processes with modes of cutting other than parting (with which at present, except for some specialized instances of planing, they are associated) as well as to combinations of them with mechanical instrumentalities. Such combinations could then be interpreted, for example, to comprise surface combustion on the cutting faces of porous ceramic cutting tools, or a set-up resembling that of a brush sliding over a commutator with the electrical and other variables suitably adjusted with a view to bringing about maximum "wear" of the commutator (workpiece) by the brush (tool).

Entirely Positive

CURRENT interest in parity or lack of it in the atomic nucleus can be seized upon as an excuse (if needed) for examining the incidence or otherwise of this characteristic in totally unrelated entities and situations. To take up one of the latter for closer examination, let us turn for a moment to the familiar situation created by a question requiring an answer. This situation is commonly regarded as exhibiting an unmistakable polarization. In the one direction there is the question to be answered, the problem to be solved or the enquiry to be supplied with the appropriate slice of information; in the other, the correct answer, the solution, or the required information. A closer, or, what is more to the point, a more prolonged examination will show, however, that this polarity is more apparent than real, and at best only temporary. It depends for its existence on an arbitrary though commonly accepted choice of time at which to examine the situation. A little later, a radical change can be observed to have taken place. A question is no longer something requiring an answer. Once it has been provided with an answer it is an integral, nicely balanced, neutral whole. An enquiry, once the information has been given, ceases to be a void to be filled with the appropriate information. The two together constitute just information exhibiting no particular bias. An adequate amount of time can do even more than this. It can turn unanswerable questions, insoluble problems, and enquiries to which no suitable information has been forthcoming, into what *after* all has been said and done, is just so much information capable of informing anybody concerned with the fact that there is, or has been, no answer, solution or information.

Other Purpose

WHENEVER pressure die-casting is under discussion, much is made of the fact that this process bridges in a single operation the wide gap between molten metal and the very nearly finished article. Compared with pressure die-casting, very little is made of the fundamentally even greater achievement of electrodeposition, which in one operation proceeds from a chemical compound in solution to the metal. Indeed, in the still relatively rarely used process of electroforming, the single step from chemical compound to a substantially finished metal part is even greater. Electroforming apart, electrodeposition is still more or less synonymous with electroplating, a surprising state of affairs when it is remembered what huge tonnages of, for example, copper, not to mention aluminium and magnesium, are produced by electrodeposition only to be melted down, cast and then mechanically worked and machined before reaching the final desired form or shape. In the circumstances, every thanks is due for such small mercies in the nature of an occasional instance of the process of metal electrodeposition being made to do something a little more than just electroplate. One such recent example is a method using electroplating in the manufacture of an abrasive tool such as a grinding wheel. In this method, a metal core of the required shape is first electroplated with tin. The tin coating is then covered with a thin layer of flux paste, and granules of the abrasive, e.g. tungsten carbide, are then distributed uniformly over the layer of flux, which serves to hold them for the time being. The abrasive-coated core is then heated to a temperature at which the tin coating melts and bonds the tungsten carbide grains to the core. Since the bond obtained in this way is too weak for practical purposes, it is strengthened by electroplating with copper and then heating in a reducing atmosphere to melt and alloy the copper and tin coatings, to form a bronze layer strong enough firmly to hold the tungsten carbide. An additional refinement, intended to prevent possible displacement of the tungsten carbide particles while the copper layer is being melted, consists in first electroplating a coating of some metal with a higher melting point than copper, which will hold the tungsten carbide in position while the underlying copper and tin coatings are being melted and alloyed.

Skimmer

Powder Metallurgy–IX

By J. F. C. MORDEN, B.Sc., F.I.M.

SINTERING is very largely carried out in the types of furnace described in a previous article (METAL INDUSTRY, 8 February, 1957) — with a prepared or inert atmosphere or *in vacuo*. Where the metals being sintered react at sintering temperatures with oxygen, some form of atmosphere control is essential, since oxidation within the pores of a compact cannot subsequently be removed. The aspects of this major technique have already been discussed, other methods, however, are being employed and will be considered briefly.

In some instances it may be convenient, instead of counteracting the effect of oxygen by the use of a prepared atmosphere, to heat the components out of contact with air by immersion in suitable liquids or solids. For this purpose, fused salts similar to those employed in the usual industrial salt baths may be used.

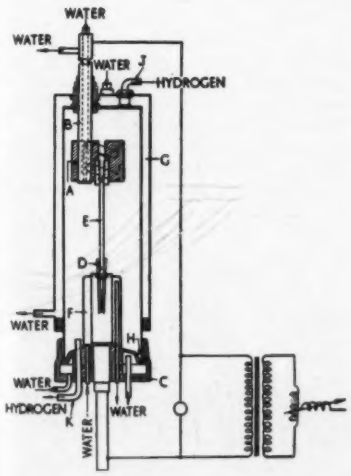
The advantage lies in the speedy and uniform application of heat, which is a feature of salt baths, but for powder metal components there is always the subsequent difficulty of removing the salt residue from the pores of the compacts, accomplished usually only by tedious washing. The salts which have been used are sodium nitrate/nitrite mixtures for temperatures in the 600°-900°C. range, carbonate / chloride/ cyanide mixtures of sodium and potassium, which are suitable for copper-base alloys, although iron compacts are better in mixtures which are mainly chlorides; and for the higher range of temperature, 900° - 1,300°C., barium salts, fluorides, silicates and borax in various combinations. Some of these mixtures are very corrosive and adequate removal treatment must follow the sintering operation.

Metallic liquids offer advantages where the compacts are subsequently to undergo infiltration, and the process in this case can be made a combination of sintering and infiltration. Lead, copper and silver have been used for the purpose but are rather troublesome in that the adherent coating of metal after the compact has been withdrawn from the bath is not easily removed. Where blanks are subsequently to be machined, however, the difficulty does not exist.

Sintering in powders contained in tightly-sealed boxes is another method which has been tried, and sand and graphite mixtures have been found successful. Mixes of iron powders, iron-aluminium powder, and various inert oxides have also been used in attempts to overcome the difficulties of sintering brass powders and avoiding dezincification. The methods are not, however, much in commercial usage.

The production of heat by electrical resistance and by high frequency induction are alternatives to that of heating by radiation and convection employed in the methods already considered, and offer certain advantages. Resistance sintering is effective with refractory materials where it is convenient to deal with compacts individually and where temperature requirements are very high. Metals such as tungsten, molybdenum and tantalum are sintered in rod form and Fig. 1[1] shows a diagrammatic cross-section through a "bell-jar" type furnace for tungsten utilizing this principle. The bottom clamp (*D*) which is movable in order to allow for the shrinkage of the rod during sintering, is immersed in mercury, which makes the electrical connection. The current passed through the rod is approximately 2,000 amp/cm^2 and the time needed is about 1 hr., during which time a temperature as high as 3,000°C. may be reached in the bell, through which hydrogen is pumped, or a vacuum maintained. Pre-sintering of the tungsten bars at 1,300°C. renders them less fragile in handling and reduces the initial resistance, which otherwise would require more complicated electrical gear.

An outstanding feature of sintering by the use of induction heating is the rapidity with which the sintering takes place, the times in some instances being as little as one-tenth of those required under similar conditions in an electric muffle.[2] This type of heating is carried out with the compacts immersed in suitable refractory powders such as alumina, magnesia and zirconia, and has the added advantages that the temperature range of heating is wide, and rapid heating and



Left, Fig. 1—Diagram showing arrangement of "bell-jar" type furnace for tungsten

A—Upper contact
B—Water cooled copper tube
C—Cast iron base
D—Tungsten clip
E—Briquette
F—Water cooled mercury trough
G—Water cooled double walled bell-jar
H—Gas-tight mercury trough
J—Inlet for hydrogen
K—Hydrogen outlet

Right, Fig. 2—G.E.C. high temperature vacuum furnace with lid raised, installed at B.S.A. Group Research Powder Metallurgy Laboratory

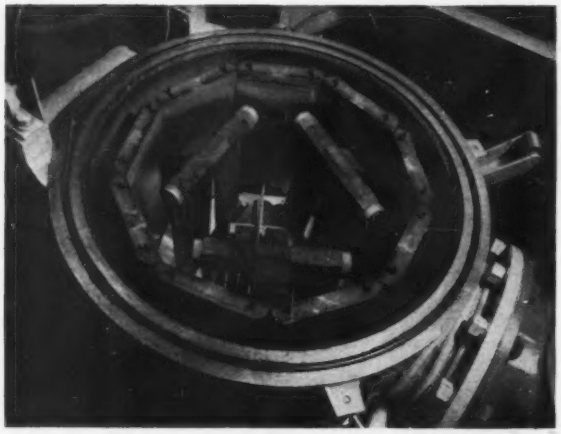


Fig. 3—Element assembly and side radiation screens of the G.E.C. high temperature vacuum furnace

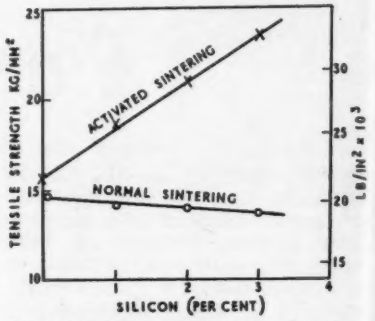


Fig. 4—Tensile strength plotted against silicon content for activated and normal sintering of a mixture of pure iron powder MH100 and silicon powder. Density 6·2 gm/c.c. sintered for 2 hr. at 1120°C.

cooling are possible. A high-frequency heating plant was illustrated in a previous article (METAL INDUSTRY, 11 January, 1957, p. 24). High-frequency heating is also most convenient for sintering *in vacuo*, which is applied particularly to metals such as titanium and zirconium which are produced by hydride reactions.[3]

Details of a G.E.C. furnace for sintering *in vacuo*, in which the charge is heated by radiation from a triangular-shaped assembly of graphite bars which surrounds the charge space, are shown in Figs. 2 and 3. A high vacuum is achieved of the order of 10^{-4} mm. and 10^{-5} mm. mercury, and temperatures up to 2,000°C. are obtainable. The furnace takes a charge approximately 9 in. diameter, 12 in. high, with a maximum weight of 90 lb. Other smaller sizes of this furnace are available.

The majority of sintering is carried out under atmospheric pressures, and since diffusion in metals shows little response to changes in surrounding pressure, there is little to be gained except in those cases where reduction accompanies the sintering. However, the use of static loading in order to assist the bonding of a powder mix to a steel backing, such as is used in the case of friction materials and discs, is a widely used device.

Powder Characteristics

The characteristics of the powder are largely felt during the compacting process and their importance was discussed particularly in the section on growth and shrinkage. Particle size and shape, as has already been indicated, affect sintering only in so far as they influence the compacting of the powder, but sintering is found to be more rapid where the proportion of "fines" in a powder is high. This is due to the fact that fine particles possess high surface energy which promotes sintering.

During sintering, three sets of conditions with regard to the powder may be encountered. There is the case where a pure metal or homogeneous alloy is being sintered; the sintering of

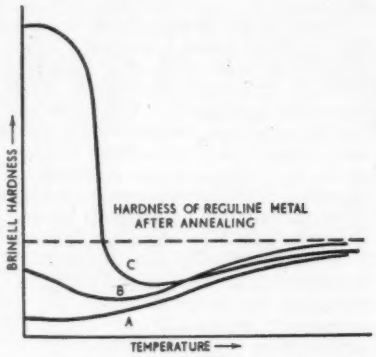


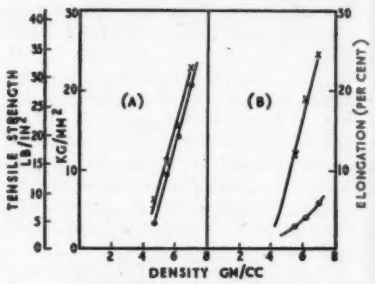
Fig. 6—Effect of sintering temperature on hardness. The figure shows schematically the effects of sintering temperature on Brinell hardness for low (A) moderate (B) and high (C) compacting pressures

a powder mix where the temperature employed is below the melting point of each of the constituent powders; and the mix where the sintering temperature is above the melting point of at least one of the constituents.

In the first two cases the bonding is largely due to atomic forces and the diffusion characteristics of the metals present. Bonding is more effective where the component metals are mutually soluble or form intermetallic compounds. Where metals form a whole series of phases, these appear during the sintering, and the properties of the resultant compacts reflect the proportions and properties of those phases present, and it is for this reason that complete diffusion may not always be desirable.

Liquid Phase Sintering

The presence of a liquid phase at the sintering temperature increases diffusion and rate of alloying considerably, but is applicable only when there is a wide margin of difference between the melting points of the metals forming the mix. The most well-known examples are those of porous bronzes and carbide hard metals where, in the first case, the tin is the



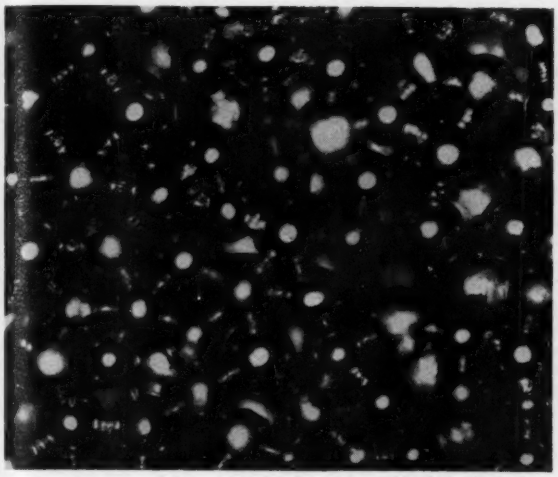
A—Tensile strength. B—Elongation
X—Activated sintering for 20 min. at 1120°C.
O—Normal sintering for 1 hr. at 1150°C.

Fig. 5—Mechanical properties of pure iron MH100 sintered with and without halogen acid

liquid phase, and in the other the cobalt. The metal which melts must not be in such high proportion that the compact tends to collapse or corners to become rounded, and in the cases quoted neither the tin nor the cobalt exceeds approximately 10 per cent. Surface tensional forces enter very considerably into the bonding under these conditions and, in general, tend to promote shrinkage because of the densification resulting from the formation of a homogeneous alloy.

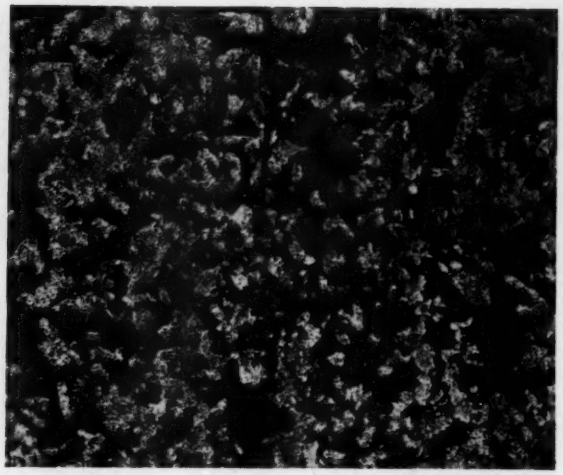
In heterogeneous mixes the liquid phase itself undergoes change due to solution, and various new phases appear, in accordance with the binary or ternary phase diagram of the metals concerned. Subsequent cooling may result in the precipitation of some of these phases. This occurs in the case of hard metals containing cobalt where, on melting, about 10 per cent by volume of liquid cobalt forms, and a limited amount of solution of the carbide occurs. On resolidification, the dissolved carbide is reprecipitated in the interstices of the coarser undissolved grains of carbide, and in this way, the liquid phase serves to accelerate the cementing process, and materially improves the toughness of the metal.

In the production of "heavy metal," consisting of tungsten containing 4-6 per cent nickel and 2-4 per cent of copper, the nickel and copper melt



[Courtesy Bound Brook Bearing Co.

Fig. 7—Surface of a porous bronze filter showing appearance of spherical particles (×200)



[Courtesy Bound Brook Bearing Co

Fig. 8—Surface of a typical porous bronze bearing. (×200)

fairly readily and enable a very dense material, having good mechanical properties, to form.[4] Sintering the tungsten by itself, even at very high temperature, results only in a porous and brittle material.

The technique of infiltration of copper into porous iron compacts, whilst not strictly liquid phase sintering, nevertheless takes advantage of the strengthening and consolidating effect that the introduction of the liquid metal has upon the metallic structure.

Activated Sintering

In his Paper at the 1954 Symposium, M. Eudier[5] discussed methods for promoting reactions between the metals being sintered and the furnace atmosphere in order to modify "the mechanism of the transport of atoms." J. A. Hedvall has also written extensively on the effects of surface activity of powders on their sintering characteristics.[6,7]

Eudier was able to demonstrate that, by forming halide compounds on the surface of iron particles and following this up by decomposing those compounds by means of a change of atmosphere, sintering was accelerated and higher strength compacts resulted; e.g. using ammonium fluoride, iron, even of low density, gave excellent ductility and sintered in 20 min. to a condition in which the results were equal to 60 min. sintering under non-activated conditions, as shown in Figs. 4 and 5.

An alternative approach consists of mixing two metals which possess similar reaction characteristics with halide, e.g. an iron powder containing a small quantity of silicon. The interaction between the iron and silicon chloride, and the silicon particles and iron chloride, accelerates the sintering and improves the sintered strength of the compacts, since the pores assume rounded contour more readily and, therefore, the notch effect of irregular particles is diminished. In the field of activated sintering further work, using oxides, chlorides, phosphates and sulphides, is showing considerable promise.

Compacting Pressure

Using low compacting pressures (Fig. 6), the hardness of the compact during sintering steadily increases as diffusion and consolidation of the structure proceed.[8] Where, however, high pressures have been employed, the particles of powder have undergone distortion and work-hardening to some extent, and the application of the sintering heat at first relieves stresses and softens the particles by promoting recrystallization, thus giving a net effect of softening the compact. Once these changes are complete the compact behaves normally and hardness gradually increases. This initial decrease in hardness is not observed where hard and non-plastic powders are concerned, since there will have been little work-hardening during compaction.

Recently, some interest has been displayed in the production of metal powder slip castings[9] in which powders are mixed with a suitable liquid medium and poured into a plaster of paris mould. The liquid is absorbed by the plaster and the metal dries in the mould. When the mould is opened the partially dry castings can be removed, dried by gentle warmth, and then sintered. In this manner, shapes not normally producible in compacting dies, such as parts with undercuts, reverse curves, projections, and screw threads, become possible. Cermets and the refractory metals[10] have also been produced with quite high densities.

For this technique, segregation of the particle sizes in the mix before pouring must be prevented by using powders with a narrow range of particle sizes, by using liquids with high density and viscosity, and the use of deflocculents.

The viscosity of the slip mix is important and is largely controlled by the ratio of solids to liquid and the temperature of the mix. The principal disadvantage lies in the large amount of shrinkage which accompanies the use of the high sintering temperature, which is needed where a good degree of densification of the component is desirable. In a study of some of the variables in this technique, H. H. Hausner and co-workers[11] have shown that uncompacted stainless steel can be sintered quite readily to densities as high as 88 per cent of the theoretical density by careful selection of powder size and distribution.

In another direction, porous metal filters have for some time been produced from spherical shaped bronze and steel powders, by sintering uncompacted aggregates of approximately uniform-sized particles, but in this case the "welding" of the particles to give adequate mechanical strength is the main purpose of sintering, and no real densification is desired (Figs. 7 and 8).

Surface Condition

The behaviour of a powder during compacting and sintering is, as would be expected, distinctly affected by its surface condition. The various methods by which powders are manufactured will result in variations of the distribution of surface lattice defects and dislocations, as well as superficial stresses, for a given metal. In general terms, the greater the amount of these defects the more will the surface tend to assume equilibrium under favourable conditions, and hence the more reactive will be the surface. This results in sintering occurring more readily.

These factors might be termed intrinsic, since they are a function of the metal and its method of preparation, but no surface is free from other

substances, which have a marked effect on the surface activity. There may be present a foreign solid phase, e.g. waxes and greases; there will be almost for certain oxides of the metal, and possibly other compounds such as carbonates and other substances related to the processes whereby the powder has been manufactured, and, in addition, there will be adsorbed and absorbed layers of gases such as oxygen, nitrogen and carbon monoxide. The manufacturing process may also have produced superficial layers of different compositions, for example, where powders have become decarburized, or even carburized.

These layers of foreign atoms or composition invariably affect the green strength of the compact and may persist to a considerable degree, even between the surfaces of the particles which have been brought into intimate contact during the compaction. Where these films do remain, diffusion is likely to be inhibited or restricted and the progress of sintering delayed, although in certain instances where solid solutions with the films are readily formed the effect is lessened, and may even stimulate sintering. Once recrystallization boundaries appear, the effect of these films is much lessened and sintering is, therefore, most rapid around the recrystallization temperature. The recrystallization temperature may be raised by undissolved films and grain growth restricted. In general, therefore, surface films are deleterious in sintering.

Mixing Time

Economically, mixing times will be kept to the minimum, but there will obviously be an optimum time for mixing. Should the time be insufficient, then a homogeneous mix will not be achieved and, as a result, sintering will proceed unevenly, producing a stressed condition in the compact as well as an unsatisfactory microstructure. On the other hand, prolonged mixing, except where the powders are hard with little plasticity, will work-harden the surfaces of the particles, adversely affecting compaction and green strength, and at the same time influencing the recrystallization process. Furthermore, prolonged mixing may easily cause the grain of the powder to coarsen rapidly during sintering, thus resulting in lower strengths. This is because grain refinement, as a result of working and recrystallization, will only occur provided the amount of work the structure undergoes exceeds a critical quantity.

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Men and Metals

An interesting feature of the recent New Year's Honours List was the award of the British Empire Medal to **Mr. Bernard Theodore Walker,** a former employee of Thomas Bolton and Sons Limited, of Stoke-on-Trent. Mr. Walker, who retired last September, was trained in all aspects of mechanical engineering, and carried out skilled and creative work in every one of them. We understand that it was the first time an employee of Thomas Bolton's had been honoured by the Sovereign for his services to the firm.

A further appointment to the board of The International Nickel Company of Canada Limited is that of **Mr. Ellmore C. Patterson,** who is also vice-president of J. P. Morgan and Company Inc.

It is reported that **Mr. C. W. M. Phillips,** A.M.I.E.E., has resigned his position as manager, Lighting Sales, A.E.I. Lamp and Lighting Company Limited, to join Britannia Engineering Company of Luton, as managing director.

News from Fielden Electronics Limited is that **Mr. E. Pearson** has been appointed assistant sales manager to the company. Mr. Pearson has been with the company for a number of years and will now be responsible for all internal and external staff associated with the sales department. **Mr. G. Ensor,** general manager of the company, has now resumed the office of sales manager in addition to his other duties.

Recently retired from the position of Registrar-Secretary of the Institution of Metallurgists, a position he had held since the inception of the Institution, **Dr. A. D. Merriman,** G.C., O.B.E., M.A., D.Sc., F.R.S.E., has been appointed consultant on scientific projects to Edgar Allen and Company Limited.

New appointments announced by Davy British Oxygen Limited are those of **Mr. J. L. Harrison** as technical sales manager and **Mr. K. T. Brightman** as assistant technical sales manager. Both these gentlemen were formerly with British Oxygen Gases Limited, and their services will still be available to this latter company for advice on the metallurgical uses of oxygen in the manufacture of iron and steel.

Joining Pena Industries Limited (then the Pena Copper Mines) as export sales manager in October last year, **Mr. Ernest G. Lennard** has now been appointed managing director of the Penco Export Company Limited, a new subsidiary of the Pena Group.

Appointed directors of Steel, Peech and Tozer, and Workington Iron and Steel Company, two branches of the United Steel Companies organization, are **Mr. K. G. Lampson, Lt.-Col. P. F. Benton Jones** and **Lt.-Cmdr. G. W. Wells.**

It is reported by The Gas Council that **Mr. R. F. Hayman,** Industrial Gas Officer of the Gas Council, has been appointed chairman of the Industrial Gas Development Committee of the Council in succession to **Mr. W. H. Tarn,** whose term of office as chairman of the committee expired at the end of December last.

Iron and Steel Research

AS is customary, the 1957 edition of B.I.S.R.A. Survey concentrates on news of research projects which have reached an interesting stage of development. The contents reflect the current interest in process control and automation. The work of the Association's Development Section in assisting industry to adopt the results of research is especially featured.

Four technical articles are of particular interest, one of which deals with progress in forge mechanization, a second describes the new system of translator control pioneered by the Plant Engineering Division. Another outlines a completely new system for the measurement of rolled rods, forgings, etc., at red heat, and the fourth gives a novel approach to blast furnace design.

Copies of the Survey are available from British Iron and Steel Research Association, 11 Park Lane, London, W.1.

AN IMPROVED DEEP-DRAWING TECHNIQUE FOR ALUMINIUM

Differential Annealing

DEEP-DRAWN aluminium products, stronger and in some cases cheaper than those previously available, may now be produced by using sheet material that has been specially prepared by a process known as differential annealing. This process, now in operation at Northern Aluminium Company Ltd., controls the temper distribution across a blank in such a manner as to make greater cupping reductions possible, and at the same time to give a stronger product than can be obtained using a uniformly annealed blank. The technique is at present being used mainly in the quantity production of large rectangular blanks over 40 in² for fish-handling boxes, but is suitable for shaped blanks or circles having a minimum diagonal length or diameter of 15 in. and a maximum length or diameter of 54 in. It is expected, however, that in time, with further development of the use of this technique, it will be possible to apply it to a larger range of sizes.

A considerable amount of research has been carried out in the past few years to establish an understanding of deep-drawing processes. Differential annealing was developed following large-scale laboratory investigations into the problems of the reduction of blanks by deep-drawing. It is well known that the base of a shell made from a soft blank remains essentially soft, whilst the strength of the wall increases gradually from base to top rim due to the work hardening of the metal in drawing. It was established experimentally that, by taking an initially hard blank and annealing the rim only, the stronger base permitted greater cupping reductions to be obtained.

Differential annealing is based on these principles; and by annealing a blank so that the distribution of retained hardness is inversely proportional to the distribution of the work-hardening pattern obtained in cupping, a container of uniform hardness (that of the material in the heavily work-hardened condition) is obtained; also bigger reductions in cupping and redrawing are obtained. Reductions of up to 60 per cent are possible, whereas the limiting reduction using a uniform blank is 50 per cent.

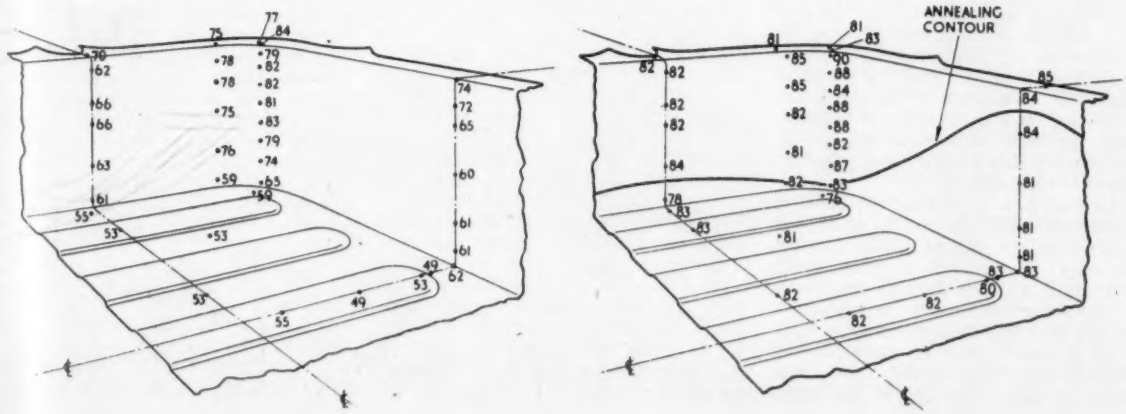
The increased hardness in the base and the more uniform hardness overall, of a box drawn from a differentially annealed blank may be clearly seen by comparing the accompanying diagrams of hardness surveys conducted on fish-boxes made from both differentially annealed and untreated blanks. Fish-boxes are now being produced in large quantities from differentially annealed blanks; these are much more robust than those used previously and so are more able to withstand the heavy handling received in the landing and loading bays of the fishing industry.

Milker pails may also be made from differentially annealed aluminium blanks; these will not only be stronger, but may be drawn in one operation instead of two. Thus, although the cost of a differentially annealed blank is slightly higher than that of a uniformly annealed blank, this is offset by the saving in production costs.

Differentially annealed blanks can, of course, also be used for spinning and, as with deep-drawing, stronger products can be obtained.

Aluminium fish boxes, made from differentially annealed material, in use at Grimsby

Hardness survey on fish boxes produced from untreated blank (left) and differentially annealed blank (right). Numbers denote Brinell hardness



Research Progress

Nucleation of Dislocations

BY RECORDER

FROM simple beginnings, dislocation theory has grown and expanded to cover many aspects of metal physics and physical metallurgy: so much so, that it seems that an ardent proponent will attempt to explain any and all phenomena in these fields by means of the theory. It is quite clear, however, that so far as the plasticity of metals is concerned, dislocations must be accepted if a rational picture of deformation mechanisms is to be obtained. There are, however, some weak points in the theory, one of which is discussed in a Paper[1] by J. J. Gilman, of the General Electric Co., Schenectady. He points out that some doubts exist about the origins of dislocations, although various mechanisms of nucleation have been proposed. For instance, "accidents" may occur during the growth of crystals, providing sites able to cause dislocation generation. Evidence that this can happen has been provided by striking (and predictable) growth patterns found on crystals of various kinds. Dislocations formed by this method depend for their existence on a more or less fortuitous misalignment of atoms condensing on the growing crystal surface. In a crystal which does not contain such sites, however, a different mechanism must be found.

Theoretical calculations have been made of the local stresses required to nucleate dislocations in a simple lattice and it has been found that very high forces should be needed. Predictions of this kind are difficult to check experimentally, a major disadvantage in the present case being the atomic scale of the processes involved and the interpretation of macroscopic effects. Gilman has found, however, that it is possible to detect with great sensitivity and selectivity the presence of dislocations in lithium fluoride crystals. With W. G. Johnston[2] he has described etching techniques that give rise to pits at the site (and only at the site) of a dislocation and probably at the sites of all the dislocations present in the etched crystal. This has provided him with a method of studying the formation and movement of dislocations in this compound which, he believes, yields results applicable to metallic substances.

In the present Paper,[1] Gilman is concerned with the effects associated with partial cleavage of lithium fluoride crystals. He found it possible to propagate a crack through part of a crystal, to complete the cleavage by a second blow and then to examine, after etching, those parts of the fractured surfaces near which the first crack came to rest. The results are illustrated by a number of interesting micrographs.

In the earlier work it had been shown that a high velocity cleavage did not substantially affect the density of dislocations in the body of the crystal. Near the front at which the first crack stopped in the present experiments, however, large numbers of etch pits could be produced, reaching a very high concentration at the front itself. Gilman states "the pits increase in density in the region where the crack was slowing down just before it stopped," but fails to comment on the fact that in two of his figures considerable numbers of pits are concentrated in a small area separated from the front by a band relatively free from pits. This might suggest either that the crack accelerated slightly just before it finally stopped or that at a particularly critical low velocity dislocations were not formed.

When the cleavage was completed by setting the crack in motion again "the number of etch pits caused by the [new] crack decreased as its velocity increased and approached zero at high velocities."

By progressively etching regions of the crystals near the stopped crack position, some additional evidence about the nature of the dislocations formed was obtained. It was observed, for instance, that the pits occurred always in pairs or multiples of 2 and that in shape the pits were asymmetric. At a certain stage in etching, the pits suddenly became flat at the bottom and could not be deepened by further etching, thus indicating that the dislocation producing the pit had been removed. Up to this point, the progressive etching caused the pits of each pair apparently to move towards each other. Gilman deduces from these facts that the pits were at the site of screw dislocations (asymmetry of individual pits) and that the crack had formed dislocation loops in the stress field ahead of the moving tip. This latter point was confirmed by examination of the two cleaved surfaces of a crystal which showed that many pairs of pits appearing on one surface were exactly matched by pairs on the other. The fact that not all pairs were so matched can be explained by the discovery that the half-loops were able to migrate in the crystals under certain stress or stress-temperature conditions. This latter phenomenon can also be used to study the movement of dislocations under various stress states, since the original position of a dislocation can be "marked" by one pit and its final position, after stressing, by another.

It is, perhaps, somewhat surprising that the dislocation loops persist in the cleaved crystal, as, when the stress at or near the tip of the crack is relieved by the ensuing fracture, the dislocations could move out of the crystal at the new surface. Gilman suggests that many loops are, in fact, probably lost in this way but that the crystal lattice offers sufficient resistance to dislocation movement to retain a reasonable number of the loops. Calculation indicates that the force tending to remove the loop is about $4{\cdot}5 \times 10^7$ dynes/cm^2, a stress of the same order as the macroscopic yield stress of the material and hence, presumably, similar to the resistance of the lattice to dislocation motion.

By further calculations, Gilman is able to estimate the energy of a typical dislocation loop and the energy of formation. By comparing these values with the stresses set up near the tip of an advancing crack, he shows that the latter stresses can exceed the required nucleation stress up to within about 50Å of the tip of the crack. Although this is an appreciable distance on an atomic scale, it is sufficiently small to explain why the dislocations, which require an incubation time under stress, are not formed if the crack velocity is higher than a certain value.

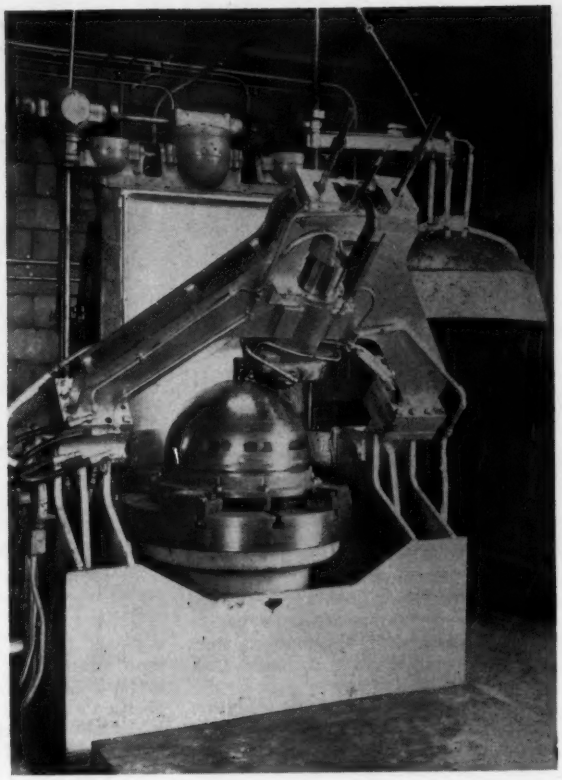
Finally, Gilman discusses the implications of his results so far as existing theories of fracture are concerned. He points out that it is at present postulated that, under stress, dislocations pile up at an obstacle, thus giving rise to high local stresses that can exceed the cohesive strength of the material. In the experiments with lithium fluoride, however, high local stresses nucleated dislocations and, since there would seem to be a strong resemblance between the stress fields set up by piled-up dislocations and by an advancing crack, it is difficult to understand why the pile-up of dislocations should not also give rise to dislocations (and hence plastic flow) rather than to fracture. It may be that the plasticity and cleavage phenomena observed in lithium fluoride crystals should not be used to criticize theories based on the behaviour of metals, but at least in the former compound the evidence is much more direct than in metals, and for that reason alone should not be lightly disregarded.

References

[1] J. J. Gilman; *Trans. A.I.M.E.*, 1957, **209**, 449.

[2] J. J. Gilman and W. G. Johnston; *J. App. Physics*, 1956, **27**, 1018.

Making Titanium Pressure Vessels



Vertical spinning lathe for hot-forming titanium hemispheres

HOT-SPINNING, welding and heat-treating processes are now being used to produce high-strength titanium alloy pressure vessels at Titanium Fabricators Inc., Burbank, California.

Such vessels are essential to the storage of gases like oxygen, helium and carbon dioxide aboard supersonic aircraft and missiles. They have previously been made from a variety of different materials — including paper fibre and stainless steels. But, due either to inadequate strength or too much weight, most of these components have not been completely satisfactory.

It is claimed that by properly fabricating a 6 per cent aluminium-4 per cent vanadium titanium alloy, spheres can be made which will retain as much pressure as comparable stainless steel vessels with about 250 per cent more weight. This is attributed not only to the relative strength and lightness of the alloy, but to structural advantages which are gained in using it to fabricate globular containers.

The initial step in making the vessels consists of cutting 6 per cent aluminium-4 per cent vanadium plate stock into circular blanks for the spinning of hemispheres with 16 in., 22 in. and 25 in. diameters. Then, prior to being formed, the blanks are preheated to 260°C.

Hemispheres are formed with a new type hot spinning machine, which can be controlled precisely and economically. This machine is unusual to the extent that it has hydraulic circuits for the control of speeds as well as pressures, and a vertical lathe frame with a floor-based table which rotates in a horizontal plane. In operation, it moves a special hydraulic yoke up and down on an axis of the great circle of a hemisphere and can exert up to 12 tons of controlled hydraulic pressure.

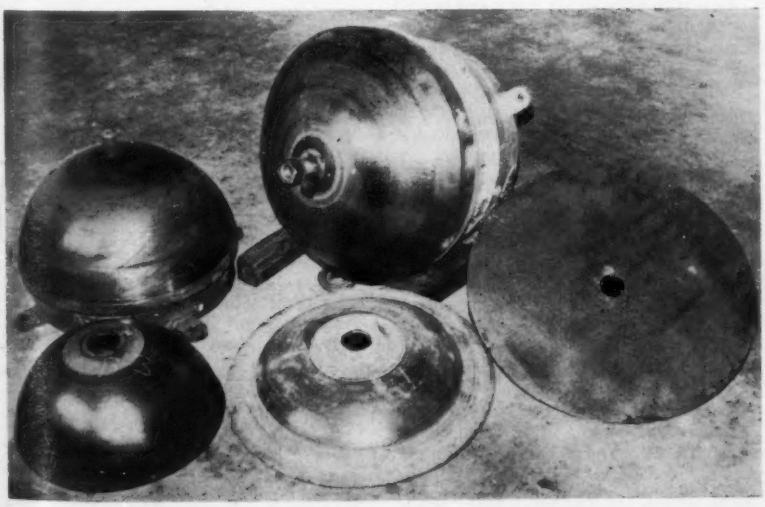
Because it can be pulled up and down at any pre-set speed and at any desired pressure, the spinning machine's yoke can be taken over its axis, and conditions required to form hemispheres with varying thicknesses and diameters can be accurately maintained.

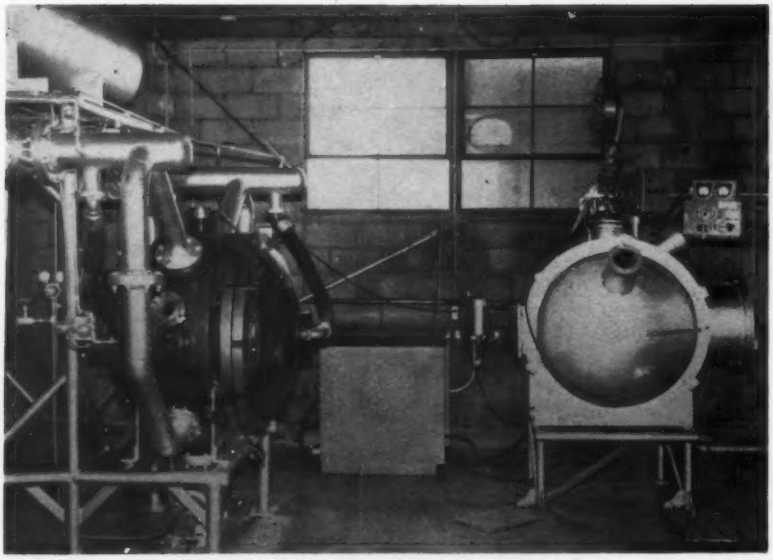
A special attachment is sometimes mounted on the machine to scarf the edges of hemispheres, so that they can be welded as soon as they have been formed. When this is impracticable, hemispheres are contour machined by removing the spinning wheel and performing a secondary operation with an appropriate cutter attached to the vertical lathe.

Pairs of hemispheres are respectively fixture-mounted in a special steel chamber, from which air is pumped so that an inert gas atmosphere can be used to prevent the oxidation of the parts when they are welded together. More or less conventional torch facilities and indexing mechanisms within the chamber are externally controlled in such a way that circumferential welds between hemispheres are produced on a semi-automatic basis.

Semi-automatic control is essential to the welding process because it simultaneously eliminates the inconsistencies of hand welding and allows a worker outside of the welding chamber to vary operating conditions

Typical hemispheres spun on the vertical spinning lathe together with one of the blanks from which they are made





Pressure chamber (right) in which hemispheres are welded in inert atmosphere, and (left) the furnace in which welded components are heat-treated and quenched

in accordance with observations and procedures which are conducive to best results.

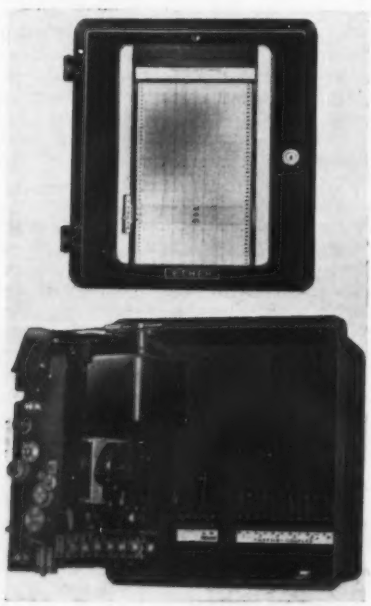
Welded pressure vessels are subsequently heat-treated in a furnace with built-in quenching facilities, the purpose of which is to minimize distortion by uniformly cooling the spheres after each has been heated.

A heating cycle consists of soaking a vessel at 927°C. for 30 min. in an inert atmosphere, after which quenching is done by allowing water from an overhead 300-gal. tank to be sprayed into the furnace so that it will instantly and evenly cool all surfaces of the component.

After being heat-treated, the vessels have 190,000 lb/in² ultimate strength and 180,000 lb/in² yield strength.

Recording Temperature

ANY number of independent temperature points from one to six may be recorded on a new temperature recorder which has been added to the range of instruments made by Ether Ltd., Tyburn Road, Birmingham, 24.



This recorder incorporates a conventional galvanometer, a chart and chart-drive mechanism, recording mechanism, automatic ribbon-mechanism and an automatic station selector and indicator.

The recording chart has a calibrated width of 6in. At a speed of 1 in/hr., it runs continuously for 30 days, and it will also run at speeds of ½ in/hr. or 2 in/hr. if desired. The chart is fed over frontal nylon drive wheels powered by a synchronous electric motor of 220-250 V, which also drives the recording mechanism. Easy loading is ensured by the presence of a hinged-front top-plate which pulls down and gives access to the chart roll.

A lightweight "chopper-bar," with calibrated scale attached, is fitted above a knife-edged galvanometer-pointer. Through the action of a timing cam and gear-train, the "chopper-bar" strikes the pointer at given intervals and imprints a small, coloured dot through the ribbon on to the recording-chart. The knife-edged pointer is attached to the galvanometer coil by means of a flexible metallic strip which reduces the disturbance and load to the precision-ground pivots at the impact of the "chopper-bar."

The galvanometer is fitted with an Alcomax II magnet, a high-resistance coil, precision-ground hardened pivots and spring-loaded polished sapphire jewels, all of which help to ensure an accurate performance even under severe operating conditions.

A completely new scanner-commutator with high-grade nickel-silver contacts is another interesting feature. This commutator has been tested under severe conditions and shows no variation in contact-resistance after five million revolutions. In fact, only after ten million revolutions is servicing necessary.

Opaque Enamels

IN exploratory experiments at Battelle Institute it has been found that the introduction of vanadium pentoxide into lead-boro-silicate compositions produced white, opaque glasses. Since such glasses are fusible and mature at temperatures from 1,125°F. to 1,200°F., qualities desirable in decorative glasses, it was natural that their use for decorating glass and aluminium should be explored.

The investigators report that white opaque enamels for glasses were developed by using three weight per cent of V_2O_5 in the raw batch. None of the usual opacifying mill additions were needed. The resulting enamels have low-maturing temperatures and pleasing appearance, and they are suitable for general-purpose applications.

Similar enamels were developed for use on aluminium. These contain eight weight per cent of V_2O_5.

Normal methods of preparing, applying and firing were employed. Some of the experimental glass enamels had marginal resistance to hot alkali solutions, while others appeared suitable for general-purpose enamels. The aluminium enamels, for which acid and weather resistance are desirable, were rated as having Class "A" acid resistance according to the Porcelain Enamel Institute's system of classification. Both types of enamel appear ready for pilot-scale trials.

Radiation Effects

A SERIES of Papers on Radiation Effects on Materials has been published as a Symposium, divided into three parts: Theory of Radiation; Radiation Facilities and Mechanics of Testing; and Experimental Tests and Results on (a) Fuel and Graphite Materials, (b) Structural Materials, including Organics, by the American Society for Testing Materials.

Copies may be obtained from the Society at 1916 Race Street, Philadelphia 3, Pa., at $4.75 a copy.

Reviews of the Month

NEW BOOKS AND THEIR AUTHORS

THERMAL STRESSES

"Thermal Stresses: With Applications to Airplanes, Missiles, Turbines and Nuclear Reactors." *By B. E. Gatewood. Published by McGraw Hill Book Co. Inc., 95 Farringdon Street, London, E.C.4, and New York. Pp. xvi + 232. Price 56s. 6d.*

AS the speeds of aircraft and missiles increase well into the supersonic range, the designer of aircraft structures meets new problems of temperatures, thermal stresses and materials to suit them. This book discusses the basic methods for solving these problems of structural design.

Many books deal with the classical problem of calculating the temperature distribution, and from it the elastic thermal stresses in a structure. This volume goes further, and deals with the combined effects of the thermal and the applied stresses, and such matters as the allowable stresses at elevated temperature, creep, fatigue, buckling, warping and flutter effects. The approach is always that of finding a good approximate solution, refined if necessary by considering the various simplifying assumptions and obtaining correction factors. It is claimed that the procedure is as accurate as some of the other steps in the design, and more accurate than the temperatures based on the heat transfer calculations. A substantial proportion of the material in this book has been published before only in technical journals and laboratory reports, and it is collected together here for the first time.

The demands on the reader's mathematical ability are not too great in the first eight chapters, in which the treatment does not go beyond elementary partial differential equations. The mathematics is closely argued, however, and needs careful reading. The ninth, and final, chapter is more demanding, and needs some knowledge of strain energy methods, and of the theory of complex variables.

Excellent features of the book are the number of worked examples given, the considerable quantity of problems for the reader to solve, and the extensive and up-to-date list of references at the end of each chapter. Very many of these references are to recent reports from various aeronautical research laboratories in the United States, and might be difficult to obtain in this country.

The book will obviously be of great value to the designer of aircraft structures and to advanced aeronautical students. For these, this book will give a good grounding in a difficult art. Despite the title of the book, the space devoted to the particular problems of turbines and nuclear reactors is small. Its value to the metallurgist is problematical. Although the introductory chapters on thermal flow and thermal stress could be useful, there are other texts which deal with this. However, reading this book will arouse the sympathy of the metallurgist for his engineering colleagues, who have a further factor added to their already complex task.

D. W. W.

METAL FINISHING

"Technical Proceedings of the 44th Annual Convention of the American Electroplaters' Society." *Published by the American Electroplaters' Society, 445 Broad Street, Newark 2, New Jersey, U.S.A. Pp. 173.*

HELD in Montreal, the 1957 Convention of the American Electroplaters' Society included six technical sessions, together with works visits and social events. This volume of the proceedings of that Convention opens with a review of the meetings and the major personalities taking part. The Papers, of which there are 22, cover a wide range of metal finishing topics, and at one session a film was shown illustrating industrial chromium plating.

At the first session, four Papers were presented dealing with levelling in copper cyanide solutions, bright and semi-bright crack-free chromium, electroplating on nickel and nickel alloys, and corrosion resistance of tin alloy deposits. A further four Papers were read at the second session, the subjects being effects of plating on high-tensile steels, the effects of different ferrous metals on the performance of a Watts nickel deposit, analytical methods for trace quantities of cyanide compounds in the plating room effluent, and accelerators and their function in phosphating solutions.

As with the majority of Symposia, the Papers presented tended to be experimental and theoretical rather than descriptions of practical plating experiences, although the Papers in the third and fourth sessions were more concerned with work in the plating shop. In the third session, the subjects were plating power, developments in electroplating with ultrasonics, materials of construction in the plating room, and plastics in electroplating plant. The fourth session included the following topics: application techniques in the use of liquid buffing compounds, the sisal story, and barrel plating.

The fifth session covered studies on nickel-iron electrodeposits, iridium plating, and surface catalyzed reduction of copper. In the sixth session were sealing of sulphuric acid anodic films on aluminium, an investigation of special electrolytes for anodizing. contaminants in phosphoric acid aluminium bright dip solutions, and chromate treatment of aluminium.

In almost every volume of proceedings which appears, whether connected with metal finishing or otherwise, a large proportion of the Papers seem to be reviews of existing processes, of current literature, or forecasts for the future. How much time these Papers occupy in their preparation and presentation is not certain, but, in view of the dearth of Papers detailing practical experience or valuable research, doubts inevitably arise as to the value of some contributions to Symposia. Has the time not yet been reached when the number of Papers presented is recognized as of lesser importance than the quality of the few? These comments should in no way be interpreted as particular criticism of the present volume; they arise as the outcome of much wider observation. These A.E.S. proceedings combine theoretical, practical and survey material in fairly balanced proportions, as in previous proceedings of the same Society, and electroplaters will find much of value within its covers.

SURFACE TREATMENT

"Jahrbuch der Oberflächentechnik, 1958." *Published by Metall-Verlag G.m.b.H., Berlin-Grunewald. Pp. 1164. Price DM.19.50.*

NOW in its 14th edition, this handbook for the metal finishing industry is, perhaps, the most comprehensive of its kind. For any reader with a command of German it is, although small, a thorough, concise, yet remarkably extensive reference book on the processes, methods and techniques of surface finishing, from initial preparation of the material, through degreasing and deposition, to the final polishing of the finished product.

Too numerous to treat with individually, the subjects dealt with include architectural applications, problems arising in atomic energy applications, grinding wheels, degreasing, ultrasonic cleaning, acid proof materials, salt bath heat-treatment, electrolytic polishing, and protective tin coatings. These are but a few of the matters dealt with in a series of technical articles which appear in the earlier part of the volume. Other articles cover passivating treatments, electroplating metal powder products, effluent treatment, and applications of silicones in metal finishing. There is also a section devoted to international patent classifications, new metal finishing patents, German and other standards, and progress in metal finishing.

The latter part of the book is

devoted to reference and tabular material, which includes trade names and a directory for buyers.

CORROSION AND WEAR

"Corrosion and Wear Handbook for Water Cooled Reactors." *Edited by D. J. De Paul. Published by McGraw Hill Publishing Co. Ltd., 95 Farringdon Street, London, E.C.4, and McGraw Hill Book Co., New York. Pp. ix + 293. Price 45s. 0d.*

ONE of a series of books sponsored by the Naval Reactors Branch of the U.S. Atomic Energy Commission, this book deals with those specific problems which arise in connection with the use of water for heat transfer in reactor plants. Broadly, the material is divided into three parts, the first of which deals with background information and general principles for those who are encountering these problems for the first time. The second part contains tabulated data and detailed information for use as reference material for actual design work, and the third section covers special types of corrosion and application problems involving wear.

The scope of the handbook may best be illustrated in a short notice of this kind by a selection of chapter headings. Part A includes fundamental aspects of iron corrosion, fundamental aspects of friction and wear, and water technology. In Part B, there are a description of testing procedures, approach to corrosion problems, tabulation of basic data, and relative importance of different variables. The third and final section, Part C, is the longest and covers crevice corrosion, stress corrosion, intergranular corrosion, corrosion products in recirculating systems, application considerations of wear, and manufacturing procedures affecting corrosion and wear.

A glossary of terms and abbreviations is given, and a comprehensive index—the value of which is so often underestimated—is included.

Large Vacuum Melting Furnace

AN unusually large furnace for melting high purity super-alloys under vacuum has recently been placed in operation by the Allegheny Ludlum Corporation at its Watervliet, New York, works.

The furnace, using the consumable electrode remelting process pioneered by the company, is capable of producing 26 in. diameter ingots, weighing up to 12,000 lb.—believed to be the heaviest ingots produced by any vacuum melting process. Previously, the largest ingots of super-alloys made by the consumable electrode process were 20 in. in diameter and weighed about 5,000 lb.

Availability of 26 in. ingots will enable the super-alloys such as A-286 to be used in many commercial applications which were previously not feasible because of restricted ingot size. For example, such components as gas turbine wheels, landing gear parts for jet transports, and large retainer rings for steam turbine generators can be made in larger sections of greater strength and dependability.

In a number of applications, such as large gas turbine wheels, high ductility and fatigue strength are required, particularly at the centre of the wheel. Ductility depends upon cleanliness and freedom from segregation in the large billet sections from which such wheels are forged. Ingots of extreme cleanliness, virtually free from segregation, are produced by this process.

A considerable amount of degasification occurs in the process, due to the formation and growth of bubbles containing gases which are expanded under the high temperatures involved. When the gas pressure becomes sufficiently high the bubble bursts, and the gases are withdrawn by the vacuum. Similarly, gases are withdrawn from smaller metal droplets on transfer from the electrode to the molten pool without bubble formation, where the high ratio of surface area to volume permits easy withdrawal of the gases.

The new, larger, furnace will also make available increased tonnages of super-alloys for use in high temperature and high stress applications in jet aircraft and engines.

In addition to high alloy steels, the consumable electrode process is also used in melting zirconium, titanium and a wide range of ferrous and non-ferrous alloys.

Lowering a copper crucible into the vacuum melting furnace. The crucible serves as the mould for the ingot of high purity alloy

Obituary

Mr. A. McLeod

IT is with regret we record the death of Mr. Alastair McLeod, head of the metallurgical editorial staff of Industrial Newspapers, Limited. Mr. McLeod received his metallurgical training in Scotland and was for many years with Frederick Braby and Company Limited, Glasgow, and other Scottish rollers of sheet steel, before moving to London to take up the editorship of *Sheet Metal Industries*.

He was a Fellow of the Institution of Metallurgists and a member of several other scientific and technical institutions.

Industrial News *Home and Overseas*

Increased Prices

It has been announced by **Suffolk Iron Foundry (1920) Limited** that they have increased the prices of certain of their welding products—aluminium, steel and iron rods, and also fluxes. There has been no increase in the price of bronzes. A copy of the new price list is available on application to the company.

A New Edition

Just published is the 1956-57 edition of **Quin's Metal Handbook,** the international annual reference book on ores, metals, iron and steel, and scrap. This new issue, the forty-third edition, comprises 703 pages and contains very extensive data relating to prices, production, consumption, exports, imports, brands and stocks of a very wide range of ferrous and non-ferrous metals. Priced at £1 5s. 0d. per copy, post free, copies may be obtained from the publishers, Metal Information Bureau Ltd., Birkett House, 27 Albemarle Street, London, W.1.

The BIMCAM Luncheon

On Tuesday of last week, the annual luncheon of the **British Industrial Measuring and Control Apparatus Manufacturers' Association** was held in London. Among the personalities present were **Mr. L. S. Yoxall,** President of the Association; **Mr. E. W. Wilson,** chairman of the Association; **Mr. S. P. Chambers,** C.B., C.I.E., deputy chairman, Imperial Chemical Industries Limited; **Mr. J. B. L. Munro,** Engineering Division, Board of Trade, and **Mr. T. E. Goldup,** President of the Institution of Electrical Engineers.

During the course of the luncheon speeches, Mr. Chambers said that as firms became larger and amalgamations occurred, the drive for industrial instruments and their better use would go forward. Mr. Wilson referred to the export record of the association for last year, in which it was expected that exports would exceed £15 million out of a total turnover of £35 million. He stressed that home trade was the basis of export sales and expressed the hope that this basis would expand with the anticipated increase of the export market when the European Free Trade area came into being.

Mr. Yoxall proposed the toast to "The Guests," and this was replied to by Mr. Goldup, who said that measurement and control was the most important factor of to-day in industry. There was also the need for men who could read the instruments intelligently. There was, he continued, an appalling shortage of technical manpower at all levels, and this was the greatest limitation on industrial progress.

Trade Enquiry

Information from the Export Services Branch of the Board of Trade is to the effect that the United Kingdom Trade Commissioner at Madras, India, has been contacted by Spencer and Co. Ltd., of P.O. Box No. 301, Mount Road, Madras 2, who wish to receive quotations from U.K. manufacturers for an electrolytic bath for dyeing and anodizing aluminium in lengths of up to 16 ft. The firm are planning to set up a workshop for the manufacture of aluminium shopfronts, as an adjunct to their current production of household furniture.

Spencer and Company were established in 1897 and are all-India agents for a number of U.K. companies. Interested manufacturers should contact this firm direct, offering quotations and marking such "for the attention of Mr. H. W. Doncaster."

Congo Copper Exports

Belgian Congo copper metal exports during the first ten months of 1957 totalled 197,070 tons, compared with 207,933 tons in the same period of 1956, according to official statistics issued in Brussels. Exports of granulated cobalt in the same 1957 period were 4,126 tons, against 3,942, while exports of cobalt alloys totalled 7,145, against 8,539 tons.

Tin ore exports in the first ten months of 1957 were 13,437, against 13,911 tons, and those of tin metal 2,245, against 2,373 tons. Zinc concentrate exports were 63,500, against 57,439 tons; zinc metal 40,343, against 32,962; manganese ore 298,156, against 276,291, and cadmium 480, against 125 tons.

The BIMCAM luncheon (left to right): Mr. J. B. L. Munro, Mr. L. S. Yoxall (President) Mr. S. P. Chambers, C.B., C.I.E. and Mr. Eric W. Wilson (Chairman)

Spanish Lead Deposits

It is reported from Avila that the Spanish mining concern Union Espanole de Minas Metalicas has applied for permission from the authorities to carry out prospecting work on 175 occurrences of lead ore in the neighbourhood of Navalonguilla, Province of Avila. In former years a number of silver and lead mines were exploited in this area.

Government Lead Disposals

Some minor changes in their plans for the disposal of lead from the Government stockpile have been announced by the Board of Trade. The total quantity of lead now for disposal in the first six months of this year (including tonnages already sold) is 6,700 tons. Of this total, an amount of 4,400 tons (including the 1,900 tons which was so offered in December) will be available for sale by open competitive tender.

Tender forms in respect of the further 2,500 tons now offered will be available from the Board of Trade, G.7, Room 316, Lacon House, Theobalds Road, London, W.C.1, for return by January 28.

Metal Finishing

On Tuesday, January 28 next, the fifth luncheon meeting of the session of the Midland area branch of **The Metal Finishing Association** is being held at the Farcroft Hotel, Handsworth, Birmingham, at 12.30 p.m. The guest speaker on this occasion is Dr. J. E. Garside, Ph.D., M.Sc., F.R.I.C., F.I.M., Principal of the Borough Polytechnic, London, and the subject of his address will be "Education in Finishing."

Corrosion Prevention

A Symposium on the protection of motor vehicles from corrosion has been arranged by the Corrosion Group of the **Society of Chemical Industry,** and will take place at the Institution of Mechanical Engineers, 2 Birdcage Walk, London, S.W.1, on Tuesday and Wednesday, March 11 and 12 this year.

Ten Papers dealing with the engine, cooling system, electrical accessories, and bodywork of vehicles, etc., will be presented for discussion by authorities from the motor industry and research organizations. Further particulars and forms of registration may be obtained from the offices of the society at 14 Belgrave Square, London, S.W.1.

Trade Exhibition Enquiry

As a result of the recent survey by the Federation of British Industries of trade associations' views on the future of trade fairs in Britain, the F.B.I. Grand Council has approved the appointment of a committee of enquiry which will consider present exhibition facilities in this country and, if necessary, will recommend plans for extending them. Its terms of reference are:—

(1) To survey the adequacy of existing exhibition facilities throughout the U.K.

in the light of the recent F.B.I. enquiry into the future trade fair policy in this country and of the possible entry of the U.K. into a European Free Trade Area; (2) to ascertain the extent to which the physical, technical and other requirements of exhibitors (including location and size of buildings and sites, availability of halls at time required, physical equipment, and amenities such as catering and hotel accommodation) are met by existing exhibition facilities; and in so far as they are not met (3) to draw up and recommend plans for new or extended exhibition facilities, including estimates of cost and proposed location.

The committee will consist of representatives of the three different elements concerned in trade fairs, i.e. exhibition organizers, exhibition contractors and exhibitors. Its members are Mr. George Pollitzer (chairman), chairman of Beck and Pollitzer Ltd. (exhibition organizers); Mr. R. W. Boardman, director of F. W. Bridges and Sons Ltd. (exhibition contractors), and Mr. W. Marrable, head of Exhibitions Department, Imperial Chemical Industries Ltd. It expects that its enquiry will take at least six months, during which time it will seek interviews with trade associations which sponsor trade fairs, in order to take into account their future requirements, and will also welcome evidence from others interested.

Italian Quicksilver

Spokesmen for two Italian quicksilver producers—the Monte Amiata Company and the Seile Mining Company—have confirmed reports that they have formed a joint sales office for the sale of their output. The office, which has been functioning from the beginning of 1958, is called Mercurio Italiano.

Tin Deposits in Russia

A new Soviet tin deposit has been discovered in the Lake Khanka area, some 100 miles north of Vladivostok, the Industrial and Economic Gazette reports. A large tin mine has been opened and an ore enrichment plant has been set up in the area. This year, in the first week of January, a first lot of 1,000 tons of tin ore was delivered to the enrichment plant.

Aluminium from Russia

Notice has been given by the Board of Trade that they are considering an application by the Aluminum Company of Canada Ltd. for the imposition, under the Customs Duties (Dumping and Subsidies) Act 1957, of an anti-dumping duty on imports into the United Kingdom of unwrought aluminium originating in the U.S.S.R.

Any representations which interested parties may wish to make in connection with this application should be addressed in writing, not later than January 24 next, to the Board of Trade, Tariff Division, Horse Guards Avenue, London, S.W.1.

Disposal of Dirt and Liquids

A new industrial vacuum cleaner which will pick up liquids as well as dust and dirt, has been introduced by the electrical equipment division of **Martindale Electric Company Ltd.** Known as the Martinet Wet-Dry suction pick-up, this new cleaner is said to be suitable for a variety of purposes in metalworking shops such as picking up dirt, oil and grease from floors and machinery and assembly lines. Metal chips from machine shop floors can also be picked up and salvaged.

This new unit consists of any standard Martindale portable blower, mounted on a rust-proof four-gallon tank, on wheels, with filter bag, hose and suction tool attachments. It can be pulled along easily by means of a handle on the blower unit and will move effortlessly over any type of flooring.

Science College Expansion

It is reported that **Imperial Chemical Industries Limited** have made a gift of £20,000 to the Manchester College of Science and Technology for expanding the departments of Chemistry, Chemical Engineering, and Mechanical Engineering, to enable the college to take more students. It is understood that the gift will be spread over a period of five years.

A Removal

Leaving their old premises at Stanmore, Middx., the **Brookside Metal Company Limited** have moved to a new address at the Watford Foundry, By-Pass Road, Watford, Herts., the new telephone number being Watford 6474 (10 lines).

Change of Address

We are informed by **M. L. Alkan Ltd.** that their address is now Stonefield Way, Victoria Road, Ruislip, Middx. Their new telephone number is Ruislip 3300 (4 lines).

Cadmium Disposals

It has been announced by the Board of Trade that in accordance with the policy set out in the 1956 Defence White Paper (Cmd. 9691, para. 125) on running down strategic holdings of industrial raw materials, they intend to dispose of 12½ tons of Cadmium metal in rod form, which represents the final balance of the stockpile. This material is being offered immediately for sale by open tender for delivery before the end of March, 1958.

Forms of tender will be obtainable from the Board of Trade, General Division 7, Lacon House, Theobalds Road, London, W.C.1, in a few days.

Birmingham Meeting

On Thursday of next week (January 23) the **Birmingham Metallurgical Society** will hold a meeting at the Birmingham Exchange and Engineering Centre, Birmingham, at 6.30 p.m., under the chairmanship of the President, Mr. R. Chadwick. At this meeting, a Paper will be presented by Mr. P. F. Hancock, B.A., F.I.M., on "Electric Furnace Developments."

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week totalled 14,795 tons, comprising London 5,162, Liverpool 8,813, and Hull 820 tons. Copper stocks totalled 19,904 tons and comprised London 11,926, Liverpool 6,308, Birmingham 1,550, Manchester 25, Swansea 475, and Hull 250 tons.

Surface Texture

In continuation of the series of "Codes of Practice," the Ministry of Defence has issued a new publication entitled **"A Guide to the Assessment of Surface Texture."** The object of this guide, which is based on B.S.1134:1950, is to make available to designers, producers and inspectors the essential information necessary for them to use up-to-date techniques on surface finish assessment in an intelligent practical manner.

The Guide is on sale at Her Majesty's Stationery Office and branches, price 3s. 0d. net.

A £4 Million Order

Orders for rolling mill equipment to the value of about £4 million have been placed with **Davy and United Engineering Co. Ltd.** by South Durham Steel and Iron Co. Ltd. as part of their newly announced expansion programme to increase plate production.

The plant will be built on a new site at West Hartlepool. Davy United's responsibility embraces over 16,000 tons of machinery and the work will be spread over their Sheffield, Glasgow and Middlesbrough works.

An Acquisition

We are informed by **F. A. Weston and Company,** of Birmingham, that they have recently acquired the brazing solder business of J. Clarke and Company (Castings) Ltd., also of Birmingham, whose customers have been notified that future enquiries should be forwarded direct to the former company.

A Birmingham Event

A one-day Symposium on **"Metallurgical Aspects of Semi-Conductors"** has been organized by the Metal Physics Committee of the Institute of Metals, to be held on Tuesday, February 25 next, at the College of Technology, Gosta Green, Birmingham. A number of short Papers will be presented. Visitors will be welcome, tickets are not required.

In conjunction with the meeting, an exhibition is being arranged at the College by the Royal Radar Establishment, Great Malvern. This will be open on February 25, and also on the previous evening, February 24.

Metal-Boron Compounds

A comprehensive range of metallic borides is now available in this country. This is revealed in an announcement by **Borax Consolidated Limited** that they are now able to supply two series of borides, one of high chemical purity (not less than 99·8 per cent) and the other comprising technical grades of minimum purity of the order of 99 per cent.

Several borides of the more important metals, such as chromium, molybdenum and tungsten, appear either in one or both of the ranges, as well as the borides of some of the less common metals, such as titanium, zirconium, vanadium, niobium and tantalum. The high melting points of metallic borides (up to 3,100°C.) and their hardness, make them compounds of major metallurgical interest.

The 11 compounds in the pure series are dense, hard powders of average particle size of 10-50 microns, and the 14 in the technical series are finer, averaging 5-10 microns in particle size.

Two technical data sheets—one for each series—have been published by the company. These list the chemical analysis, specific gravity, melting point and hardness of each compound. The electrical conductivities, which are of some importance in certain applications, are also included.

News from Birmingham

Labour troubles tend to disturb the industrial position in the Midlands. Since the opening of the year, the strike in the cycle trade has resulted in the loss of many hours of work and considerable

The sales conference dinner of W. Canning & Co. Ltd., at the Queen's Hotel, Birmingham

output, and there is also a dispute at one of the principal motor factories which at present, though not an actual stoppage, has an unsettling effect on labour. Nevertheless, unemployment remains at only 1 per cent generally over the Midand Region and there are still vacancies for skilled and semi-skilled workers in the engineering and metal industries. Brassfounders are well employed on work for railways and the motor trade. Some workers in the aircraft factories have been declared redundant.

Demand for iron and steel is heavy, particularly from the motor trade, shipbuilding, rolling stock and heavy electrical equipment manufacturers. The shortage of heavy steel plates has not yet been overcome, and some material is being imported, although not so much as a year ago. Because of some lessening of demand for small steel bars, stocks of billets are increasing. Similarly, the amount of pig iron available for production of light castings is more than the trade can absorb. On the other hand, the flow of work to firms making heavy engineering castings is maintained. Mills rolling heavy structural steel are fully engaged for the time being, though new building contracts are not being given out so freely because of the credit squeeze.

Exhibits in Birmingham

New exhibits recently installed at the Birmingham Exchange and Engineering Centre are as follows:—**Griffiths, Gilbart, Lloyd and Co. Ltd.** provide an exhibit showing examples of their deep drawn pressings in ferrous and non-ferrous metals. Many light pressings are shown for use in a varied range of industries.

Dowding and Doll Ltd. have installed a panel display showing examples of thread milling hobs, thread crushing rolls and thread chasers; and **John Rigby and Sons Ltd.** have introduced a well illuminated display of metal sinterings.

A Sales Conference

On Friday evening of last week the annual sales conference of **W. Canning and Company Ltd.** was brought to a conclusion with a dinner given by the directors to over 100 members of the sales staff and executives at the Queen's Hotel, Birmingham. Sir Ernest Canning, chairman of the company, presided. In addition to the Birmingham staff, the company's representatives from London and Sheffield were also present.

Tin Outlook

Production and consumption of tin in the world in 1958 will be in almost exact balance at around 130,000 tons, according to a forecast in the January tin market review, published by **A. Strauss and Co.** The review said that if the restriction quota remained at the present level throughout the year, the amount of metal available from these countries within the restriction scheme should amount to 108,000 tons. Other countries' exports should total about 11,000 tons, and Russian exports were forecast at 12,000 tons.

The review estimated that there would be a fall of about 30,000 tons in world consumption, making a total of 130,000 tons for 1958, the lowest figure since 1949. If the price remained around £730 a ton, the Buffer Stock, with the resources pledged by the participating countries, would be in a position to take, if necessary, a further 10,000 tons off the market. Whatever the long-term prospects, a considerable market movement looked likely in the next few months.

Forthcoming Meetings

January 20—Institution of Production Engineers. Coventry Section. Craven Arms, High Street, Coventry. "Impact Extrusion and Cold Flow Pressing of Ferrous and Non-Ferrous Metals." H. Byles. 7.15 p.m.

January 20—Institute of Metal Finishing. London Branch. Northampton Polytechnic, St. John Street, London, E.C.1. "Some Properties and Applications of Chemically Reduced Nickel Coatings." A. McL. Aitken. 6.15 p.m.

January 21—Institute of Metal Finishing. South-West Branch. Grand Hotel, Bristol. "Hard Chromium Plating of Gun Barrels." R. A. F. Hammond. 7 p.m.

January 22 — Non-Destructive Testing Society of Great Britain. Birmingham Branch. Engineering Centre, Stephenson Place, Birmingham, 2. "Metallurgical Origins of Defects in Castings." V. Kondic. 7 p.m.

January 22 — Institution of Production Engineers. Worcester Section. Cadena Café, Worcester. "Metal Finishing." A. W. Wallbank. 7.30 p.m.

January 23—Institute of Metals. Birmingham Local Section. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2. "Electric Furnace Developments." P. F. Hancock. 6.30 p.m.

Scrap Metals and the Clean Air Act

MUCH regret has been expressed by the members of the non-ferrous scrap industry at the decision of the Ministry of Housing and Local Government not to accept for registration under the Clean Air Act processes for the recovery of metals from scrap cable by burning the insulation. The effect of this is that decisions regarding the emission of black smoke from such operations will lie with the local authorities.

The application for inclusion under the Act was made by the National Association of Non-Ferrous Scrap Metal Merchants, the Joint Non-Ferrous Scrap Committee and other interested parties, and so far there is no information that any appeal against the Ministry's decision is to be made. It would appear that the Ministry considered carefully the representations submitted to him but recognized that the main responsibility for reducing air pollution "rightly rests with the local authorities." He had also, it is stated, taken into account the defences available under Section 1 of the Clean Air Act in the case of emission of dark smoke, the Regulations to be made under Section 1 (2), the period which is allowed for necessary improvements to plant under Section 2, and the protection afforded by Section 109 of the Public Health Act of 1936, in the case of emissions subject to the Nuisance Provisions of that Act.

Applications from other sections of the metal trades which have, however, received approval include the following:—iron and steel works, copper works, aluminium works, sulphate reduction works, and references to these various sections of the industries concerned are contained in the lengthy statement issued by the Ministry containing the decisions.

At the public enquiry into these questions in October, 1956, the Association of Municipal Corporations stated that whilst they did not question that there were industries which presented technical difficulties upon which the advice of experts would be necessary, they maintained that the control of smoke, grit and dust should remain a matter of local concern and that effective control should be vested in the local authorities.

Metal Market News

LAST week saw a new low for copper since trading in futures began in August, 1953, for cash in midweek declined on the afternoon market to £175 10s. 0d. sellers, while three months stood at £178 15s. 0d. On the same day, in the afternoon, news came through that the custom smelters in the United States had reduced by 50 points to 25 cents. A feature of the market was the narrowing of the contango, a process that has been going on now for some weeks. L.M.E. stocks are high, around 20,000 tons, but it would appear that much of this is held in strong hands and that, therefore, only a proportion of the 20,000 tons is available for day-to-day trading. Actually, the stock figure at the beginning of last week showed a reduction of 250 tons to 20,054 tons, but it seems not unlikely that this is only a passing phase and that the upward trend will be renewed. Tin stocks, on the other hand, were 1,079 tons up at 13,201 tons, which sets up a new high record for recent months. In all the metals, consumer demand was rather poor and it looks as though the holiday spirit is still with us. On the Metal Exchange, turnovers were moderate, although copper had two good days in midweek, admitting that the proportion of carries was high. Actually, some 7,200 tons of copper were traded, while the turnover in tin was 1,800 tons, of which a fairly high proportion was for the cash position. This suggests that the Tin Council was again supporting the market and at the close the quotation for cash was £730 to £730 10s. 0d.

In spite of talk about the likelihood of the American lead price being reduced in the near future, the market in London was very steady and, indeed, higher on balance, for both positions improved to the extent of 25s. The Board of Trade has announced its intention of varying the original arrangement for their disposal of lead so that the tonnage does not weigh so heavily on the market. In the case of all these Government disposals where metal has to be returned to the producers or their agents, it is obviously not very attractive for these people to re-purchase material which has already been sold by them. At the close of the week, January lead stood at £73, with April at the same figure. Zinc also gained ground to close £2 2s. 6d. up at £63 10s. 0d. for January, while April gained 30s. at £63. It will be noticed that there was a backwardation of 10s., due, it would appear, to influential buying of the early position. Demand is reasonably good and some quarters report an improvement in business with the galvanizers, but all buyers are showing a good deal of caution. The upward movement in zinc is rather surprising, for the situation in the States is certainly not favourable inasmuch as the most recent statistics show a big increase in stocks. So far the price in London has held up above £60, but anything like a reduction in the U.S. quotation might well cause a sharp setback here.

The question of a reduction in U.S. values arises also in regard to copper, for it must be admitted that 27 cents, equal to £216, is a price quite divorced from reality. The custom smelters have shown the way by coming down to 25 cents, but even that is a long way above the London parity, and it is pretty certain that copper is being offered at a substantial reduction below this. Doubtless the producers will do all in their power to hold 27 cents, even though this level is unrealistic at the present time. If this level can be maintained, then, it seems not unlikely that around £175 will prove to be the bottom of the market, for the moment, at any rate. It is understood that there is a good deal of dissatisfaction among American semis manufacturers about the volume of imports from the U.K.

New York

With the advent of the New Year, non-ferrous metals generally continued to show laggard activity. In copper, custom smelters reported meagre sales at 25½ cents per lb. with the undertone shaky. Producers sold a light amount of copper at 27½ cents. Dealers were selling copper at 24¾ cents Valley delivered, but even here fabricators were buying in limited quantities. Custom smelter sources said the poor activity and the disparity between the L.M.E. price and their price was intensifying pressure on the 25½ cent level. Trade sources believed that the producer price at 27 cents was more stable than the lower custom smelter price, because of the need for custom smelters continuously to sell their output.

The copper trade is closely watching developments in Chile, where a struggle is reported to be going on within the Government as to whether Chile should cut back her copper production by ten per cent. Hitherto, when it appeared that Chile was ready to approve cutbacks in production by the large mines, the economic and political considerations involved in such cutbacks negated the move.

Meanwhile, with U.S. Congress reconvening for the new session, the drive for an increase in the copper tariff was accelerated. Governor Ernest W. McFarland, of Arizona, sent a letter to the Governors of the forty-seven other states seeking their co-operation and assistance in the fight to obtain adequate tariff protection in his state's copper mining industry. He stressed the point that present tariff protection and the 24 cent "peril point" were far out of line with current production costs and American standards of living. In his letter, he said an exhaustive study indicated the justification of a 32 cent peril point and restoration of the original four cent excise tax.

Lead and zinc at best were spotty, with the hope for a stable price pinned on Tariff Commission recommendations for maximum allowable tariff rates. Informed sources said that before these rates would become effective — assuming the administration approval of the expected Tariff Commission duty hikes—a few months might pass, and there was uncertainty whether lead and zinc prices would be able to hold in the interim. The disparity between London and New York prices in both metals was a negative influence in the market, traders said, and intensified foreign competition in the U.S.

Tin was steadier, aided by some advance in London and an improved dealer buying interest.

Chile

The Chilean Copper Department has authorized an adjustment in copper production which will mean a ten per cent reduction from 1956 output. At a special session, the Copper Department reaffirmed the principle that any general adjustment in copper production must affect higher cost producers to a greater extent. In view of the national interest and that of all sections of the copper industry, the Department said it was making the following recommendation to the producing enterprises of Chile's big copper mining industry:

(1) Production should be adjusted to the terms of effective demand of all markets during 1958.

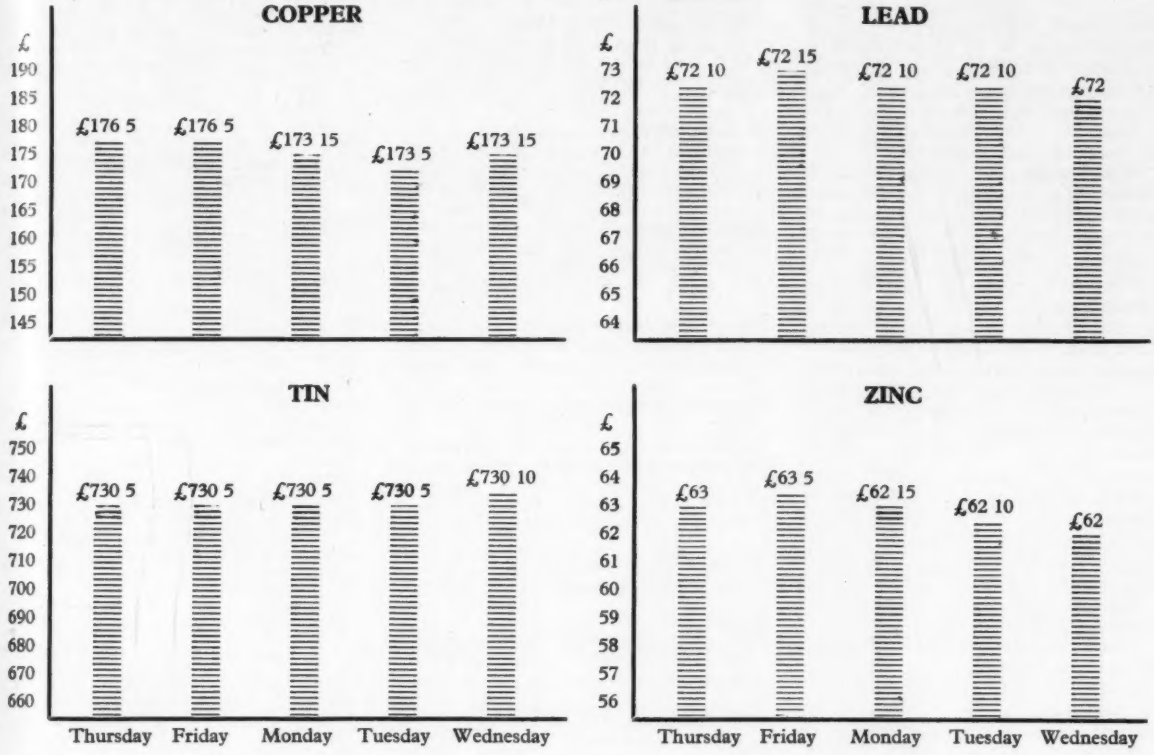
(2) The Copper Department believed that for this purpose, production should be set at about 90 per cent of that achieved in 1956, and gave this as a statistical reference sufficiently clear for all concerned.

(3) The recommendation would definitely have to be revised if Chile's attitude did not find in the comparatively near future the general collaboration which was indispensable in measures of this kind.

Large mine copper production in Chile in 1957 was as follows: Chuquicamata—electrolytic 155,844 metric tons, blister 83,847; Potrerillos—blister 39,168; El Teniente—blister 89,683, fire refined 65,898. The overall copper production in 1957 of 434,480 metric tons compares with 1956 production at the same mines of 442,420 tons. The reduction is due to the strike at the Chuquicamata mine in April.

METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 9 January 1958 to Wednesday 15 January 1958



OVERSEAS PRICES

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton	Canada c/lb ≏ £/ton	France fr/kg ≏ £/ton	Italy lire/kg ≏ £/ton	Switzerland fr/kg ≏ £/ton	United States c/lb ≏ £/ton
Aluminium		24.63 203 10	198 172 5 0	400 232 0	2.50 209 0	28.10 224 17 6
Antimony 99.0			195 169 12 6	440 255 5		33.00 264 0
Cadmium			1,400 1,218 0	2,800 1,624 0		155.00 1,240 0
Copper						
Crude						
Wire bars 99.9				360 208 17 6		
Electrolytic	25.00 182 15	26.50 218 17 6	230 200 2 6		2.25 188 2 6	27.00 216 0
Lead		12.25 101 2 6	123 107 0	185 107 7 6	.92 77 0	13.00 104 0
Magnesium						
Nickel		71.50 590 10	1,060 922 5	1,330 771 10 0	8.10 677 2 6	74.00 592 0
Tin	101.00 738 7 6		880 765 12 6	1,420 823 12 6	9.00 752 6	93.75 750 0
Zinc						
Prime western		10.00 82 12 6				10.00 80 0
High grade 99.95		10.60 87 10 0				
High grade 99.99		11.00 90 5				
Thermic			107.12 93 2 6			
Electrolytic			115.12 100 2 6	157 91 0	.87 72 15	11.75 94 0

NON-FERROUS METAL PRICES

(All prices quoted are those available at 12 noon 15/1/58)

PRIMARY METALS

		£	s.	d.
Aluminium Ingots	ton	197	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		10	0
Calcium	„	2	0	0
Cerium 99%	„	13	18	0
Chromium	„		6	11
Cobalt	„		16	0
Columbite	per unit		—	
Copper H.C. Electro	ton	173	15	0
Fire Refined 99·70%	„	172	0	0
Fire Refined 99·50%	„	171	0	0
Copper Sulphate	„	71	0	0
Germanium	grm.		3	4
Gold	oz.	12	8	8½
Indium	„		10	0
Iridium	„	27	0	0
Lanthanum	grm.		15	0
Lead English	ton	72	0	0
Magnesium Ingots	lb.		2	5½
Notched Bar	„		2	10½
Powder Grade 4	„		6	3
Alloy Ingot, A8 or AZ91	„		2	8
Manganese Metal	ton	300	0	0
Mercury	flask	70	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	
Palladium	„	7	10	0
Platinum	„	28	10	0
Rhodium	„	40	0	0
Ruthenium	„	16	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	5½
Tellurium	lb.		15	0
Tin	ton	730	10	0
Titanium	lb.		19	6
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	61	12	6
Dust 95/97%	„	104	0	0
Dust 98/99%	„	110	0	0
Granulated 99+%	„	86	12	6
Granulated 99·99+%	„	102	17	6

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

†**Aluminium Alloy**		£	s.	d.
B.S. 1490 L.M.1	ton	154	10	0
B.S. 1490 L.M.2	„	158	10	0
B.S. 1490 L.M.4	„	182	0	0
B.S. 1490 L.M.6	„	204	10	0

†Average selling prices for November.

***Aluminium Bronze**				
BSS 1400 AB.1	ton	211	0	0
BSS 1400 AB.2	„		—	
***Brass**				
BSS 1400-B3 65/35	„	133	0	0
BSS 249	„		—	
BSS 1400-B6 85/15	„		—	
***Gunmetal**				
R.C.H. 3/4% ton	ton		—	
(85/5/5/5)	„	164	0	0
(86/7/5/2)	„	175	0	0
(88/10/2/1)	„	219	0	0
(88/10/2/½)	„	228	0	0
Manganese Bronze				
BSS 1400 HTB1	„	175	0	0
BSS 1400 HTB2	„		—	
BSS 1400 HTB3	„	195	0	0
Nickel Silver				
Casting Quality 12%	„		nom.	
„ „ 16%	„		nom.	
„ „ 18%	„		nom.	
***Phosphor Bronze**				
2B8 guaranteed A.I.D. released	„	248	0	0
Phosphor Copper				
10%	„	211	0	0
15%	„	219	0	0

**Average prices for the last week-end.*

Phosphor Tin				
5%	ton		—	
Silicon Bronze				
BSS 1400-SB1	„		—	
Solder, soft, BSS 219				
Grade C Tinmans	„	345	3	0
Grade D Plumbers	„	279	6	0
Grade M	„	378	3	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	96	2	6
Mazak V	„	100	2	6
Kayem	„	106	2	6
Kayem II	„	112	2	6
Sodium-Zinc	lb.		2	5

SEMI-FABRICATED PRODUCTS

Prices of all emi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium			£	s.	d.
Sheet 10	S.W.G.	lb.		2	9
Sheet 18	S.W.G.	„		2	11
Sheet 24	S.W.G.	„		3	2
Strip 10	S.W.G.	„		2	9
Strip 18	S.W.G.	„		2	10
Strip 24	S.W.G.	„		2	11½
Circles 22	S.W.G.	„		3	3
Circles 18	S.W.G.	„		3	2
Circles 12	S.W.G.	„		3	1
Plate as rolled		„		2	8½
Sections		„		3	2½
Wire 10 S.W.G.		„		3	0
Tubes 1 in. o.d. 16 S.W.G.		„		4	1
Aluminium Alloys					
BS1470. HS10W.					
Sheet 10	S.W.G.	„		3	1½
Sheet 18	S.W.G.	„		3	4
Sheet 24	S.W.G.	„		3	11½
Strip 10	S.W.G.	„		3	1½
Strip 18	S.W.G.	„		3	3
Strip 24	S.W.G.	„		3	11
BS1477 HP30M.					
Plate as rolled				2	11½

Aluminium Alloys—*cont.*		£	s.	d.
BS1470. HC15WP.				
Sheet 10 S.W.G.	lb.		3	9½
Sheet 18 S.W.G.	„		4	1½
Sheet 24 S.W.G.	„		4	11½
Strip 10 S.W.G.	„		3	10½
Strip 18 S.W.G.	„		4	1½
Strip 24 S.W.G.	„		4	9
BS1477. HPC15WP.				
Plate heat treated	„		3	6½
BS1475. HG10W.				
Wire 10 S.W.G.	„		3	10½
BS1471. HT10WP				
Tubes 1 in. o.d. 16 S.W.G.	„		5	0
BS1476. HE10WP.				
Sections	„		3	2
Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Brass Tubes	„		1	5
Brazed Tubes	„		—	
Drawn Strip Sections	„		—	
Sheet	ton		—	
Strip	„	209	5	0
Extruded Bar	lb.		1	8½
Extruded Bar (Pure Metal Basis)	„		—	
Condenser Plate (Yellow Metal)	ton	147	0	0
Condenser Plate (Naval Brass)	„	158	0	0
Wire	lb.		2	2½
Bronze Sheet and Strip	ton		—	
Copper Tubes	lb.		1	8½
Sheet	ton	200	5	0
Strip	„	200	5	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	225	5	0
Cupro Nickel				
Tubes 70/30	lb.		3	2½
Lead Pipes (London)	ton	115	5	0
Sheets (London)	„	113	0	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Rods	lb.		—	
Sheet and Strip 7%	„		3	3½
Wire 10%	„		3	10
Phosphor Bronze				
Wire	„		3	5½
Titanium				
Billet	lb.	4	10	0
Sheet	„	6	12	0
Wire	„	9	10	0
Tube	„	16	0	0
Zinc Sheets, English destinations	ton	96	15	0
Strip	„		nom.	

LATE NEWS

Madrid—It is reported here that workable deposits of titanium and iron ores have been discovered on the small island of Lobos, which lies between the islands of Lanzarote and Fuerteventura (Canary Islands). The Spanish Ministry of Industries is stated to have granted prospecting licences covering the deposits.

Financial News

Light Metal Statistics

Figures showing the U.K. production, etc., of light metals for Oct., 1957, have been issued by the Ministry of Supply as follows (in long tons) :—

Virgin Aluminium	
Production	2,358
Imports	11,181
Despatches to consumers	20,509
Secondary Aluminium	
Production	11,144
Virgin content of above	1,466
Despatches (including virgin content)	10,944
Secondary in Consumption (per cent)	
Wrought products	4·8
Cast products	80·3
Destructive uses (aluminium content irrecoverable)	60·7
Total consumption	26·0
Scrap	
Arisings	13,861
Estimated quantity of metal recoverable	9,795
Consumption by:	
(a) Secondary smelters	12,848
(b) Other users	1,021
Despatches of wrought and cast products	
Sheet, strip and circles	12,784
Extrusions (excluding forging bar, wire-drawing rod and tube shell):	
(a) Bars and sections	2,791
(b) Tubes (i) extruded	377
(ii) cold drawn	818
(c) (i) Wire	2,878
(ii) Hot rolled rod (not included in (c)(i))	331
Forgings	346
Castings: (a) Sand	1,966
(b) Gravity die	4,189
(c) Pressure die	1,567
Foil	2,159
Paste	278
Magnesium Fabrication	
Sheet and strip	5
Extrusions	25
Castings	230
Forgings	4

LIGHT METALS STATISTICS IN JAPAN
(October, 1957)

Classification	Production	Shipment	Stock	Export
Alumina	13,036	12,931	14,755	0
Aluminium				
Primary	6,382	5,439	3,637	20
Secondary	1,437	1,455	365	0
Rolled Products	4,965	4,972	1,495	564
Electric Wire	686	742	769	6
Sheet Products	1,350	1,413	—	51
Castings	1,608	—	—	—
Die-Castings	800	—	—	—
Forgings	43	—	—	—
Powder	—	—	—	—
Primary Aluminium (November)	5,735	5,419	3,953	162
Sponge				
Titanium	150	—	—	116
Magnesium	50	49	6	0
Secondary	154	151	80	0

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons, Limited, Company Registration Agents, Chancery Lane, W.C.2.

W. A. G. Hanbury (Christchurch) Ltd. (594291), 50B Bargates, Christchurch. Registered November 26, 1957. To take over business of general merchants carried on as "Hanburys" at Christchurch; manufacturers of and dealers in scrap metals and waste products of all kinds, etc. Nominal capital, £50 in £1 shares. Permanent directors: H. W. Lord and Mrs. M. A. Lord.

Cemented Carbide Dies and Tools Limited (594509), 4 New Burlington Street, W.1. Registered November 29, 1957. Nominal capital, £100 in £1 shares. Permanent directors: D. G. Warner and T. H. Godsmark.

Cemented Carbides Limited (594510), 4 New Burlington Street, W.1. Registered November 29, 1957. Nominal capital, £100 in £1 shares. Permanent directors: D. G. Warner and T. H. Godsmark.

North Western Electro Plating Co. Limited (594611), 12 Garfitt Street, Oldham. Registered December 2, 1957. Nominal capital, £1,500 in £1 shares. Directors: F. Wilson, J. Wright and R. Worstencroft.

Engineering Metals Limited (594738), 83 The Drive, Ilford Essex. Registered December 4, 1957. Nominal capital, £100 in £1 shares. Director: D. Laren.

Rhondda Pressings Limited (594776), Tycha Wen, Tonyrefail, Glam. Registered December 4, 1957. To carry on business of manufacturers and merchants of metal and other pressings, etc. Nominal capital, £1,200 in £1 shares. Directors: B. M. Williams and K. Russell.

A. A. Bramall (Leeds) Limited (594783). Midland Bank Chambers, 22a Derby Road, Stapleford, Nottingham. Registered December 4, 1957. To take over business of non-ferrous metal merchants, being part of the business carried on at 27a Low Road, Hunslet, Leeds, 10, by "A. A. Bramall, Ltd.," etc. Nominal capital, £5,000 in £1 shares. Directors: A. A. Bramall and J. M. Bramall.

M.L. Sheet Metal Products Limited (594837), 50 Holly Road, Twickenham, Middx. Registered December 5, 1957. Nominal capital, £1,000 in £1 shares. Director: J. W. Emmel.

Strip Tinning Limited (594845), 17 Lewisham High Street, S.E.13. Registered December 5, 1957. To carry on business of metal enrobers, metal sprayers, etc. Nominal capital, £500 in £1 shares. Directors: C. J. A. Barton and W. Collie.

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 14/1/58.

	£
Aluminium	
New Cuttings	158
Old Rolled	130
Segregated Turnings	95
Brass	
Cuttings	122
Rod Ends	112
Heavy Yellow	90
Light	85
Rolled	112
Collected Scrap	87
Turnings	107
Copper	
Wire	152
Firebox, cut up	152
Heavy	145
Light	140
Cuttings	152
Turnings	136
Braziery	120
Gunmetal	
Gear Wheels	153
Admiralty	153
Commercial	125
Turnings	120
Lead	
Scrap	63
Nickel	
Cuttings	—
Anodes	540
Phosphor Bronze	
Scrap	125
Turnings	120
Zinc	
Remelted	53
Cuttings	44
Old Zinc	29

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton.) :—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£156.12.6)	180
Heavy copper	(£152.5.0)	175
Light copper	(£130.10.0)	150
Heavy brass	(£95.15.0)	110
Light brass	(£78.7.6)	90
Soft lead scrap	(£56.10.0)	65
Zinc scrap	(£34.17.6)	40
Used aluminium unsorted	(£87.0.0)	100
France (francs per kilo):		
Copper	(£213.2.6)	245
Heavy copper	(£213.2.6)	245
Light brass	(£156.0.0)	180
Zinc castings	(£69.12.6)	80
Tin	(£565.10.0)	650
Aluminium pans (98½ per cent)	(£139.5.0)	160
Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£194.7.6)	335
Aluminium copper alloy	(£104.10.0)	180
Lead, soft, first quality	(£88.15.0)	153
Lead, battery plates	(£53.7.6)	92
Copper, first grade	(£168.5.0)	290
Copper, second grade	(£153.15.0)	265
Bronze, first quality machinery	(£174.0.0)	300
Bronze, commercial gunmetal	(£145.0.0)	250
Brass, heavy	(£116.0.0)	200
Brass, light	(£107.7.6)	185
Brass, bar turnings	(£121.17.6)	210
New zinc sheet clippings	(£58.0.0)	100
Old zinc	(£43.10.0)	75

THE STOCK EXCHANGE

Steel Shares Steadier After Renewed Heaviness

ISSUED CAPITAL *	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 14 JANUARY	+RISE —FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1957 HIGH	1957 LOW	1956 HIGH	1956 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	19/6		10	10	10 5 3	28/3	18/–	25/–	20/–
400,000	2/–	Anti-Attrition Metal	1/3		8½	7½	13 12 0	2/6	1/6	2/2½	1/6½
33,639,483	Stk. (£1)	Associated Electrical Industries ...	48/6		15	15	6 3 9	72/3	47/9	85/7½	57/3
1,590,000	1	Birfield Industries	51/3	—1/9	15	20N	5 17 0	70/–	48/9	110/7½	48/9
3,196,667	1	Birmid Industries	57/–	+3d.	17½	17½	6 2 9	80/6	55/9	81/9	58/9
5,630,344	Stk. (£1)	Birmingham Small Arms	26/1½	—4½d.	10	8	7 12 0	33/–	21/9	39/9	20/–
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/–		5	5	6 13 3	16/–	15/–	18/6	14/10½
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6% ...	16/6		6	6	7 5 6	19/–	16/6	21/6	17/9
500,000	1	Bolton (Thos.) & Sons	28/9		12½	12½	8 14 0	30/3	28/9	31/–	29/6
300,000	1	Ditto Pref. 5%	15/3		5	5	6 11 3	16/9	14/3	18/1½	15/9
160,000	1	Booth (James) & Co. Cum. Pref. 7%	19/–		7	7	7 7 3	22/3	18/9	23/–	21/6
9,000,000	Stk. (£1)	British Aluminium Co.	42/–	+3d.	12	12	5 14 3	72/–	38/3	81/10½	40/6
1,500,000	Stk. (£1)	Ditto Pref. 6%	18/6		6	6	6 9 9	21/6	18/–	21/10½	19/6
15,000,000	Stk. (£1)	British Insulated Callender's Cables	39/3	—9d.	12½	12½	6 7 6	55/–	40/–	54/9	45/3
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	29/7½	—1/10½	10	15N	6 15 0	39/–	29/6	63/6	32/3
600,000	Stk. (5/–)	Canning (W.) & Co.	20/3		25	25	6 3 6	24/6	19/3	25/6	19/–
60,484	1/–	Carr (Chas.)	2/3		25	25	11 2 3	3/6	2/1½	3/–	2/4½
150,000	2/–	Case (Alfred) & Co. Ltd.	4/7½		25	25	10 16 9	4/6	4/–	5/–	3/10½
555,000	1	Clifford (Chas.) Ltd.	15/9		10	15N	12 14 0	20/6	15/9	35/–	21/1½
45,000	1	Ditto Cum. Pref. 6%	15/10½		6	6	7 11 3	17/6	16/–	19/–	17/9
250,000	2/–	Coley Metals	4/6		25	25	11 2 3	5/7½	3/9	5/1½	3/7½
8,730,596	1	Cons. Zinc Corp.†	49/3	—3d.	22½	22½	9 2 9	92/6	49/–	70/7½	46/3
1,136,233	1	Davy & United	47/–	+9d.	15	12½	6 7 9	60/6	42/6	50/6	41/3
2,750,000	5/–	Delta Metal	20/10½		*17½	*17½	4 3 9	28/6	19/–	25/9	18/3
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	24/6	—9d.	15B	22½	10 4 0	38/6	25/–	39/7½	30/–
500,000	1	Evered & Co.	41/–	—1/–	15	15	7 6 3	52/9	42/–	56/–	52/–
18,000,000	Stk. (£1)	General Electric Co.	37/3	—9d.	14	12½	7 10 3	59/–	38/–	65/6	41/3
1,250,000	Stk. (10/–)	General Refractories Ltd.	27/9	—3d.	17½	17½	6 6 0	37/–	26/9	33/6	24/1½
401,240	1	Gibbons (Dudley) Ltd.	64/6		15	12	4 13 0	71/–	53/–	54/–	50/–
750,000	5/–	Glacier Metal Co. Ltd.	5/9	—1½d.	11½	11½	10 0 0	8/1½	5/10½	8/6	6/3
1,750,000	5/–	Glynwed Tubes	13/–		20	20	7 13 9	18/–	12/6	18/3	15/9
3,614,032	10/–	Goodlass Wall & Lead Industries ...	29/3	—3d.	18	16	6 3 0	37/3	28/9	34/7½	26/10½
342,195	1	Greenwood & Batley	46/10½		17½	17½	7 9 3	50/–	46/–	48/–	45/–
396,000	5/–	Harrison (B'ham) Ord.	12/3		*15	*30‡	6 2 6	16/9	12/4½	42/9	14/10½
150,000	1	Ditto Cum. Pref. 7%	18/9		7	7	7 9 3	22/3	18/7½	25/–	22/–
1,075,167	5/–	Heenan Group	7/–	—3d.	10	20‡	7 2 9	10/4½	6/9	‖8/6	6/6½
142,045,750	Stk. (£1)	Imperial Chemical Industries ...	38/–	—1/–	10	10	5 5 3	46/6	36/3	50/–	36/6
33,708,769	Stk. (£1)	Ditto Cum. Pref. 5%	16/9		5	5	5 19 6	18/6	15/6	19/9	16/3
14,584,025	**	International Nickel	138	—2	$3.75	$3.75	4 17 0	222	130	210	141½
430,000	5/–	Jenks (E. P.) Ltd.	14/10½	—1½d.	27½	27½	9 5 0	18/10½	15/1½	18/3	15/–
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	15/–		5	5	6 13 3	17/–	14/6	18/–	16/3
3,987,435	1	Ditto Ord.	40/–		10	9	5 0 0	58/9	40/–	52/–	40/9
600,000	10/–	Keith, Blackman	16/–	—3d.	15	15	9 7 6	21/9	15/–	25/10½	18/9
160,000	4/–	London Aluminium	4/1½	+3d.	10	5	9 14 0	6/9	3/6	8/–	5/–
2,400,000	1	London Elec. Wire & Smith's Ord....	41/–		12½	12½	6 2 0	54/6	41/–	52/9	42/6
400,000	1	Ditto Pref.	21/3		7½	7½	7 1 3	25/3	21/9	26/–	24/–
765,012	1	McKechnie Brothers Ord.	37/6		15	15	8 0 0	48/9	37/6	58/1½	50/6
1,530,024	1	Ditto A Ord.	36/3		15	15	8 5 6	47/6	36/–	58/–	46/9
1,108,268	5/–	Manganese Bronze & Brass	9/6	+4½d.	27½‡	25	7 4 9	21/10½	7/6	18/9	15/4½
50,628	6/–	Ditto (7½% N.C. Pref.)	5/9		7½	7½	7 16 6	6/6	5/–	6/3	5/6
13,098,855	Stk. (£1)	Metal Box	42/6	—9d.	20‡	15M	4 14 0	59/–	40/3	54/6	41/6
415,760	Stk. (2/–)	Metal Traders	6/4½	—1½d.	50	50	15 13 9	8/–	6/3	8/–	5/10½
160,000	1	Mint (The) Birmingham	22/9	+3d.	10	10	8 15 9	25/–	21/6	25/3	22/6
80,000	5	Ditto Pref. 6%	83/6		6	6	7 3 9	90/6	83/6	92/6	84/6
3,064,930	Stk. (£1)	Morgan Crucible A	36/3		10	11	5 10 3	54/–	35/–	48/3	38/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/–	—3d.	5½	5½	6 9 6	19/3	16/–	20/7½	18/–
2,200,000	Stk. (£1)	Murex	55/9	—1/6	20	20	7 3 6	79/9	57/–	74/–	60/–
468,000	5/–	Ratcliffs (Great Bridge)	6/10½	—3d.	10	10Y	7 5 6	8/–	6/10½	10/3	7/–
234,960	10/–	Sanderson Bros. & Newbould ...	25/6	+9d.	27½D	27½	7 3 9	41/–	24/9	38/–	33/–
1,365,000	Stk. (5/–)	Serck Radiators	11/4½		17½Z	15	5 2 6	18/10½	11/6	16/3	12/3
600,400	Stk. (£1)	Stone (J.) & Co. (Holdings)	44/–	+3d.	16	16	7 5 6	57/6	43/9	59/6	49/–
600,000	1	Ditto Cum. Pref. 6½%	19/10½	—1½d.	6½	6½	6 10 9	21/9	18/9	21/9	20/3
14,494,862	Stk. (£1)	Tube Investments Ord.	52/3	—9d.	15	15	5 14 9	70/9	50/6	70/7½	50/9
41,000,000	Stk. (£1)	Vickers	29/6	—9d.	10	10	6 13 6	46/–	29/–	44/6	32/4½
750,000	Stk. (£1)	Ditto Pref. 5%	15/6		5	5	6 9 0	18/–	14/–	18/7½	15/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	22/–	+6d.	*5	*5	7 0 3A	24/9	20/7½	25/6	22/6
2,200,000	1	Ward (Thos. W.), Ord.	71/9		20	15	5 12 9	83/–	64/–	69/3	58/9
2,666,034	Stk. (£1)	Westinghouse Brake	34/–	—3d.	10	18P	5 17 9	85/–	29/1½	100/6	68/–
225,000	2/–	Wolverhampton Die-Casting ...	7/3	—4½d.	25	40	6 18 0	10/1½	7/–	14/10½	8/–
591,000	5/–	Wolverhampton Metal	15/–	—1/–	27½	27½	9 3 3	22/3	14/9	21/10½	16/–
78,465	2/6	Wright, Bindley & Gell	3/9	+1½d.	20	17½E	13 6 9	3/9	2/7½	3/9	2/6
124,140	1	Ditto Cum. Pref. 6%	11/6		6	6	10 8 9	12/6	11/3	14/–	12/4½
150,000	1/–	Zinc Alloy Rust Proof	2/9	+1½d.	40D	33½	9 14 0	5/–	2/9	4/–	2/9

*Dividend paid free of Income Tax. † Incorporating Zinc Corpn. & Imperial Smelting. ** Shares of no Par Value. ‡ and 100% Capitalized issue. * The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. H and 200% capitalized issue. M and 10% capitalized issue. Y and 25% capitalized issue. ‖ Adjusted to allow for capitalization issue E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/– per share or £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B Equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue.